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Water Plant Optimization Study

TIMMINS WATER TREATMENT PLANT

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WATER PLANT OPTIMIZATION STUDY

Part 1 - Timmins Water Treatment Plant
Part 2 - Buffalo-Ankerite Water Treatment Plant
Part 3 - Whitney-Tisdale Water Supply

Project No. 7-2043

December 1990

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WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 1

TIMMINS WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of this Water Plant Optimization Study is to document the existing components of the three independent water supplies serving the three largest communities in the City, to assess their performance and to determine or recommend optimum treatment strategies.

In general terms, the Study consists of an accurate and detailed description of the water supply facilities including flow rates, loadings and other parameters under design conditions and under actual conditions and tables documenting three years of operating data and treatment results, covering the period 1984 to 1986. Also included is a description of the mode of operation as well as recommendations for optimizing the performance and for long and short term improvements.

It is the intent that this Study, which forms part of the Ontario Ministry of the Environment ongoing Drinking Water Surveillance Program, be updated annually.

The City of Timmins comprises a very large area which surrounds the former Town of Timmins. Within this area are various population centres. The largest by far is the Timmins community. This three part Report investigates the water supplies for Timmins itself (Part 1), as well as for two smaller communities, namely Buffalo-Ankerite (Part 2) and Whitney-Tisdale (Part 3).

The Report finds that the Timmins plant generally produces water of a very good quality, despite the fact that the raw water is not easy to treat. However, a detailed investigation of the plant records indicates that on occasion the consistency of the applied chemical

dosages can be improved. Also, in the opinion of the Ministry of the Environment, some further improvements in the treated water quality are obtainable.

A new and comprehensive bacteriological sampling and testing program by plant personnel was instituted early in 1987 to replace an earlier program conducted by the Porcupine Health Unit. Because of this, the bacteriological test results for the three year study period are somewhat incomplete.

The physical improvements recommended are the addition of dedicated metering pumps for filter aid, sampling pumps for raw water and filtered water, a day tank for supplementary alum, the purchase of sludge blanket density measuring equipment, as well as the installation of continuously recording turbidity meters and a residual chlorine analyzer. Other recommendations pertain to maintaining separate records for each pretreatment process and for each filter.

Consideration should also be given to an application to M.O.E. for funding of a research project that would establish the role of various combinations of pretreatment chemicals in the flocculation and clarification processes during the seasons, leading to an improved understanding by the operating staff of the very complex processes that take place. The project could also produce a Manual of Procedures for Pretreatment. Some initial work in this direction has been undertaken by the Ministry of the Environment, by conducting a treatability study (as appended) in August, 1987. The study concluded that a combination of alternative treatment chemicals under certain conditions can produce lower residual alum and TTHM values in the treated water than the values obtained at the plant.

For the Buffalo-Ankerite system it has been found that bacteriologically safe water has always been supplied but that residual chlorine is difficult to maintain in the system water. More frequent sampling and higher chlorine dosages are recommended in conjunction with the installation of a recording residual chlorine analyzer. Another short term improvement to be considered is the installation of

an automatic starting standby generator to prevent the depressurization of the distribution system during power failures to eliminate the ingress of possible contaminated groundwater.

The long term improvement required to consistently produce water with low turbidity and low colour is the addition of coagulation, flocculation and clarification facilities for pretreatment.

The Whitney-Tisdale system, which at the time of writing this report took all its water from wells is, since October, 1988, supplied through a long transmission main by the Timmins Water Treatment Plant. This has changed the entire operation and made much of the equipment redundant.

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 1

TIMMINS WATER TREATMENT PLANT

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WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 1

TIMMINS WATER TREATMENT PLANT

1.0 INTRODUCTION AND TERMS OF REFERENCE

The Ontario Ministry of the Environment has instituted a Drinking Water Surveillance Program (DWSP), consisting of a continuously updated base of information on Ontario water treatment plants and water quality. In connection with the surveillance program, a specific plant investigation and evaluation study "Water Plant Optimization Study" (WPOS) is to be carried out for each plant entering the program. The study is to document and review the present conditions and to determine an optimum treatment strategy for contaminant removal at the plant. A detailed Protocol for this Water Plant Optimization Study has been prepared by the Ministry and distributed to the Consultants engaged for the Optimization Studies. This study has been conducted in accordance with the Protocol, a copy of which is attached as Appendix 1.

The City of Timmins is responsible for the water supply and distribution facilities for the following three completely separated communities:

Timmins	--	serviced population	36,000 (1986)
Whitney-Tisdale	--	serviced population	8,000 (1986)
Buffalo-Ankerite	--	serviced population	250 (1986)

Figure 1 illustrates the geographic separation between the communities. During the preparation of this study, construction was underway to link the two larger systems by means of an 8 km long transmission main in order to phase out the limited capacity aquifer that now supplies the Whitney-Tisdale community. Start-up occurred in September of 1988.

The Optimization Studies are to include a detailed examination of three years daily and monthly operating data. However, on account of the future phasing out of the Whitney-Tisdale supply, and because of the

very small population serviced by the Buffalo-Anchorite system, the Ministry has recommended that the latter two studies be reduced in scope. Consequently, only two months of data (one in winter, one in summer) for each of the last three years have been included.

For reasons of easier reference, and because the smaller supplies may eventually be dropped from the Drinking Water Surveillance Program, this study has been prepared in three parts, one for each supply:

Part 1 -- Timmins Water Treatment Plant
Part 2 -- Buffalo-Ankerite Water Treatment Plant
Part 3 -- Whitney-Tisdale Water Supply

2.0 HISTORY OF THE TIMMINS WATER TREATMENT PLANT

The first water intake and original pumping station were constructed by the Hollinger Consolidated Gold Mines in 1924. Water was supplied to the Town under 10 year renewable agreements until 1968 when the mine closed and the Town purchased the water supply facilities. In 1972, the pumping station and intake were incorporated in a new water treatment plant with a rated capacity of 27.3 ML/d. Very rapid growth of the Town, as well as amalgamation with surrounding municipalities to create the City of Timmins led to the construction of an expansion in 1984/1985 that doubled the capacity to 54.6 ML/d. Some of the Hollinger constructed works, such as raw water well, two high lift pumps, and pump room are still in service.

3.0 GENERAL DESCRIPTION

The geological conditions of the site dictated that all construction be restricted to the upper 4 m thick crust of the very deep local marine deposits of sand, clay and silt. Below this depth, allowable bearing conditions are insufficient. This condition necessitated that the filtered water storage tanks not be constructed in the conventional

location underneath the filters, but instead, at the same elevation and adjacent to the treatment building. Filtered water must therefore be pumped by transfer pumps to the ground level storage tanks, and finally repumped by high lift pumps to the distribution system.

The 1972 plant features low lift pumps, dual flocculation tanks, followed by two settling tanks and three Microfloc supplied filters. The 1985 addition, which doubled the capacity, added a very similar parallel plant, with major process components supplied by Degrémont. Its major difference is that coagulation and settling are combined in two shallow sludge blanket clarifiers. This saved considerable floor area and capital cost. The new facilities came on stream in May, 1985.

Each of the two plants can operate independently. However, one new rapid mix tank is now in general use, which supplies both plants with raw water mixed with coagulant. If desired, the coagulant dose to one plant or the other can be augmented in order to allow for differences between the two processes. For ease of reference in this report, the older facilities will mostly be referred to as the 1972 plant, or in the case of the filters, as Neptune-Microfloc or Microfloc, the media supplier. The newer addition will often be described as the 1985 plant, or for process specific components, as Degrémont.

Figure 2 illustrates in a simplified version the main components of the plant. It is of interest to note that for historical reasons there exist five mains feeding the distribution system, each with its own flow meter. Hollinger mines constructed the two 500 mm diameter mains in the 1920's. The 250 mm main diameter served Mountjoy Township before it amalgamated with the City, the 400 mm diameter main was constructed by the City to supply more water to Timmins North, and the 750 mm diameter main was completed in 1987 to reinforce the supply to Timmins South and to become part of the transmission line to Whitney-Tisdale.

The raw water can be regarded as typical for Northern Ontario surface water, i.e. soft, very high in colour and with low turbidity. The plant removes colour very effectively by using high dosages of primary

coagulant. The report finds that the overall plant performance is very good, however, an improved understanding by the operating staff of the very complex pretreatment process caused by the many variable factors involved during the seasons would be of assistance in optimizing the treatment.

SECTION A - RAW WATER SOURCE

A:1 Location

The plant is located on the Mattagami River, within the City of Timmins, immediately upstream of the original Town of Timmins. The Mattagami River at this location drains an area of approximately 5,300 km^2. The watershed contains an artificial storage reservoir and power generating station owned and operated by Ontario Hydro, located some 25 km upstream of the plant. Except for one factory, there are no industries or communities of any significance in the catchment area, but there is a continued urbanization in Mountjoy, the western City area, which is bound to contribute some contaminated surface runoff to the river just upstream of the intake. The one factory, Malette Waferboard Board Corporation, is located approximately 15 km upstream. It produces sheathing for the construction industry manufactured from wood chips.

The Mattagami River produces an average annual flow of 73 m^3/sec, while the minimum flow recorded is 10 m^3/sec.[1]

A:2 Quality

The raw water can be characterized as soft, low in alkalinity and turbidity, and high in colour. Variations occur seasonally, and sometimes as a result of activities by Ontario Hydro.

The following values cover the three year period 1984-85-86.

	Maximum	Minimum	Average
Physical			
Turbidity (FTU)	10.2	.79	1.77
Colour (TCU)	100	30	43.2

(1) Mattagami Valley Conservation Authority

	Maximum	Minimum	Average
Chemical			
pH	7.4	5.2	6.9
Alkalinity (mg/L)	62.4	21.5	32.9
Hardness (mg/L)	54.4	31.0	40.9

Microbiological

No data are available because no sampling and testing program was or is in existence. Although the plant is equipped with a raw water sampling pump, the pump suction is located downstream from the point of prechlorinization, which is located near the mouth of the intake pipe. A separate sampling line to the river would be required to obtain unchlorinated water.

A:3 Discussion

Although it may appear from the above extreme values that relatively wide fluctuations are possible, the raw water quality variations in actual practice are relatively minor. As an example, the maximum turbidity value of 10.2 FTU occurred once in three years, the next highest values are 9.0 - 8.3 - 7.2 - 6.4 - 5.1, also all occurring once only. This leaves 1089 days, or 99.5% of total time for turbidity to be below 5.1 FTU. The swings in other parameters are comparably low.

Mostly, the variations in quality occur seasonally, but sometimes also as a result of river flow variations initiated by Ontario Hydro.

Sampling of raw water for bacteriological testing purposes is not practiced because the existing raw water sampling pump is located downstream of the prechlorination application point.

SECTION B - **FLOW MEASUREMENT**

B:1 **Description of Flow Metering Equipment**

The details of the various flow meters in the plant, as well as a description of the principal equipment items are shown on page B-2. The meter numbering system is illustrated in Figure 3, Process and Piping Diagram.

B:2 **Raw Water Flow Metering**

B:2.1 **General Discussion**

Raw water from the raw water well can be pumped by means of independent piping to the 1972 plant. The newest 750 mm diameter main, terminating in the Rapid Mix chamber, is normally the only one in use. The older 600 mm diameter has been retained for standby reasons only. Both mains contain Pitot tube type inserts as primary measuring elements and differential producers. The devices, of which a great many have been used in the plant, are characterized by very low initial cost for purchase and installation. The differential pressure signal produced at low velocity in the pipe line is not high and, consequently, the accuracy of the flow measurement at low flow rates is limited. Because raw water flow measuring is mainly done to pace chemical feed rates, repeatability rather than accuracy is the main criterion, and in this respect the devices are providing good service.

B:2.2 **Validity**

The absolute accuracy of the "old" meter in the 600 mm diameter main is impossible to verify. Daily raw water flows prior to the summer of 1985 showed a somewhat erratic pattern when compared with finished water flows. Often, raw water quantities were 3 to

FLOW METERING EQUIPMENT

METER NO.	SERVICE	LOCATION	PRIM. ELEMENT	CAPACITY L/s MAX.	MIN.	DETAILS OF INSTRUMENTATION
5	Raw water	600 dia. raw water main in building basement	Pitot tube Annubar	600	110	Bailey E21-17 transmitter Bailey recorder for meters #5 and #6 Totallizer for total raw water flow
6	Raw water	750 dia. raw water main	Pitot tube PSE Inc. S-100	750	180	Rosemount 1151 DP transmitter
1	Treated water distribution system	500 dia. meter chamber	C.I. Venturi BIF	600	200	Bailey E21-17 transmitter Bailey recorder for meters #1 and #2 complete with totallizer for meters #1 to #4
2	Treated water distribution system	600 dia. meter chamber	Insert Venturi BIF 182-24B	800	300	Rosemount 1151 DP transmitter
3	Treated water distribution system	500 dia. meter chamber	Pitot tube PSE Inc. S-100	800	200	Rosemount 1151 DP transmitter Bailey recorder for meters #3 and #4 complete with totallizer for total flow
4	Treated water distribution system	400 dia. meter chamber	Pitot tube PSE Inc. S-100	800	300	Rosemount 1151 DP transmitter
7	#1, #2 & #3 filter backwash	400 dia. b.w. main	Orifice	400	200	Bailey P21-19 transmitter Flow indicator and totallizer
8	#4, #5 & #6 filter backwash	400 dia. b.w. main	Insert Venturi BIF 182-16C	570	300	Rosemount 1151 DP transmitter Flow indicator and totallizer

NOTE: Meter Numbers refer to Figure 3 - Process and Piping Diagram

6% higher than finished water, sometimes 10% and sometimes less than finished water. On the whole 5% seemed a common value that could also be readily justified on the basis of calculated volumes of waste streams for desludging and filter backwash for the Microfloc plant.

Following the start-up of the Degrémont plant in 1985, a lengthy gap occurred in the raw water flow recording, due to problems with the "new" meter in the 750 mm diameter main. Thus, no reliable records for 1986 are available. At the present time, the raw water meter is registering flows that are in the order of 7% higher than the finished water readings. A volumetric fill or draw test to verify the records was not possible. An assessment, however, was made of the waste streams by actual volumetric measurement of the desludging of the Degrémont plant and by estimating the filter backwash flows under average flow conditions of 22,000 m^3/d. The following values are considered to be very close to actual conditions:

Auto desludging Degrémont:	288 min/day x 2.7 m^3/min	= 778 m^3/d
Auto desludging Microfloc:	96 min/day x 2.7 m^3/min	= 259 m^3/d
Manual desludging Microfloc:	30 min/day x 4.0 m^3/min	= 120 m^3/d
Degrémont filter backwash:	2 filters/day @ 100 m^3	= 200 m^3/d
Degrémont filter surface wash:	2 filters/day @ 30 m^3	= 60 m^3/d
Microfloc filter backwash:	2 filters/day @ 350 m^3	= 700 m^3/d
Microfloc filter surface wash:	2 filters/day @ 3 m^3	= 6 m^3/d
Microfloc filter-to-waste:	2 filters/day @ 18 m^3	= 36 m^3/d
TOTAL WASTE WATER:		2,159 m^3/d

The above calculation demonstrates that at the present time the differential between raw and finished water is in the order of 10%.

In view of the excellent and consistent results obtained from the verification tests on the finished water meter and the inconsistency between the ratio of raw to finished water flow records, it was decided that for this report the raw water flow quantities would be more realistic if derived from finished water meter readings by means of a constant multiplier. The multipliers

used are 1.05 for the period prior to March 15, 1985, and 1.10 thereafter. All flow tables and chemical dosages have been recalculated accordingly.

As a matter of interest, the reason for the larger waste quantity and larger multiplier after March 15, 1985, is mainly in the automatic desludging cycle introduced for both pretreatment processes, as illustrated by the detailed estimate for the various waste streams.

B:3 Treated Water

B:3.1 General Discussion

Treated water can be pumped into the distribution system via four mains, each of which is metered. The signals of all meters are summated and daily flows are read from one integrator. The location of the meters, numbered from 1 to 4, is shown on Figure 3 - Process and Piping Diagram.

Meter #1 is a 500 mm diameter cast iron Venturi installed in 1924. Together with Meter #4, they are registering most of the flows produced. This is because High Lift pumps #4, #5 and #6 are the most frequently used pumping units.

Meter #2 is a 600 mm diameter insert type Venturi. This meter registers flow only when pumps #7 and #8 are in service.

Meters #3 and #4 are of the Pitot tube type. Meter #3 is in an emergency by-pass line, which is normally kept closed.

B:3.2 Validity

Finished water flow is measured at high velocity and the meters have been found accurate to within 0.7 and 1.5% in two separate clear well level draw-down tests conducted in January and February of 1987.

B:4 **Backwash Water**

B:4.1 **General Discussion**

The backwash water flow to filters #1, #2 and #3, and to filters #4, #5 and #6, is governed by a separate rate controller, one for each group of three filters. Each unit consists of a flow meter, a flow control valve and a controller that compares the measured flow signal with a preset value and adjusts the valve position until the two signals match. The meters are #7 and #8. The primary function of the rate control valve in the automatic backwash cycle is to preset the desired backwash rates, i.e. gradually increasing flows until a plateau is reached. Backwash water is obtained directly from the clearwells and the quantity is thus not reflected in the metered quantity supplied to the distribution system. Backwash quantities for both groups of filters are totallized separately. There is no flow recorder.

B:4.2 **Validity**

It was tried in the plant to check the accuracy of the backwash water flow indicators and totallizers by measuring rise rates in the Microfloc and Degrémont filters. However, automatic interlocks between drain gate closure and backwash pump operation made this impossible. All information on backwash flow rates is thus derived from meters with unknown accuracy.

B:5 **Filtered Water**

Each filter has its own rate controller, which governs the quantity of water produced by each individual filter. The 3 Microfloc controllers are governed by one master rate setting device, and the 3 Degrémont filters are governed likewise. The flow from each filter is individually measured and recorded.

B:6 **Calibration**

The flow meters are calibrated twice a year by an instrument technician associated with one of the large mining companies.

B:7 **Flow Data Storage**

All data collected on plant flows is entered on daily or monthly forms. All forms are kept in separate files and stored in the plant building.

B:8 **Daily Demands**

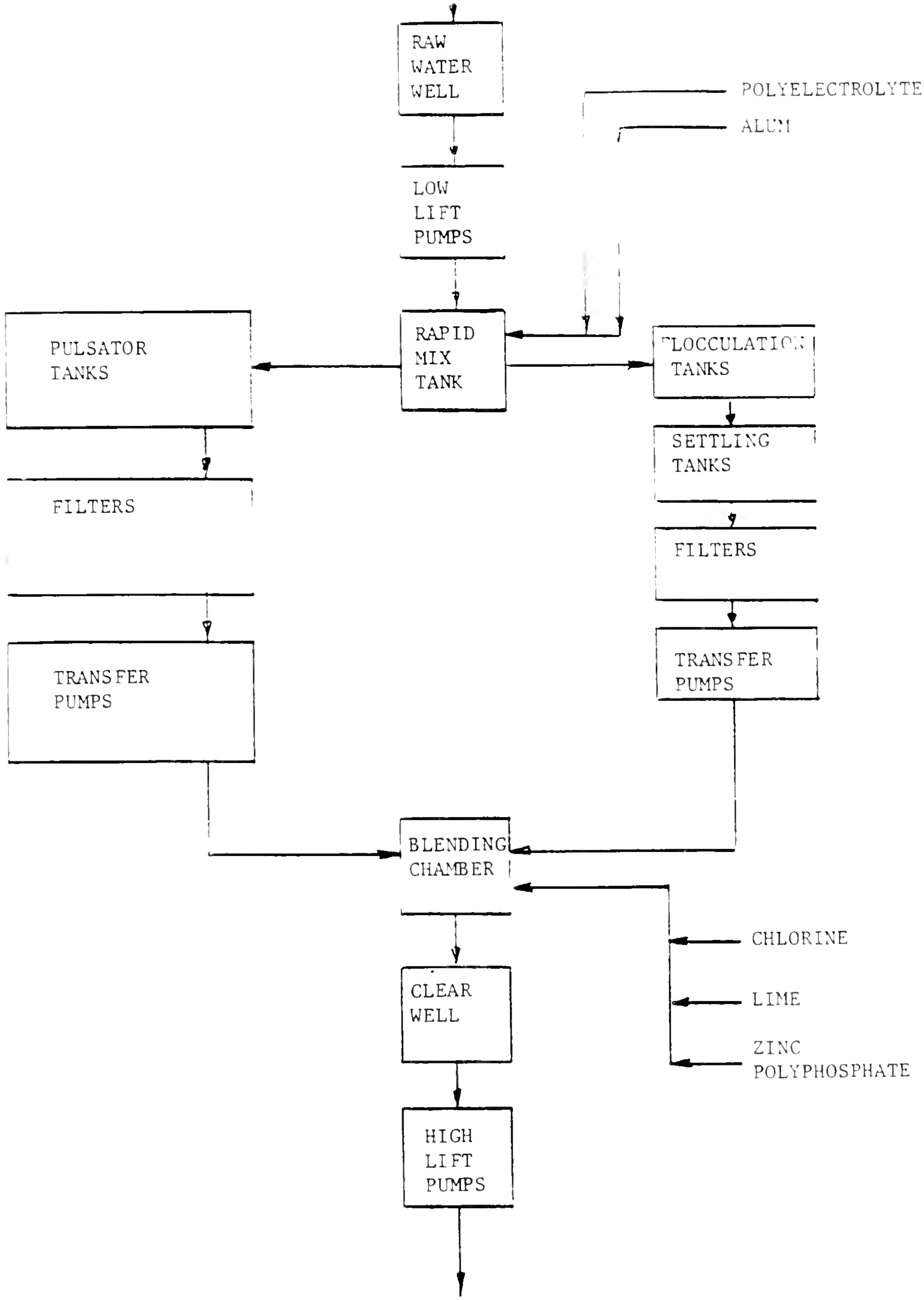
In order to better judge the daily demands, it is considered necessary to adjust for the very high consumption by McIntyre Mines Ltd. in Schumacher, which constitutes the largest single user by far. On an average daily basis, the mine is using 1,457 m^3 (based on 1985 and 1986 records). The table below shows both unadjusted and adjusted values.

DAILY DEMANDS (ML/d)

	Unadjusted			Adjusted		
	Average	Maximum	Minimum	Average	Maximum	Minimum
1984	18.9	27.7	10.7	17.5	25.8	9.3
1985	19.7	37.7	10.1	18.3	36.3	8.7
1986	22.7	45.5	14.9	21.3	44.1	13.5

The per capita consumptions which have not been adjusted, are reproduced in Table 1.1. After adjustment for the McIntyre Mines demand, the annual average per capita consumptions are .49, .51 and .59 m^3/d. These values are considered normal.

The apparent increase for 1986 over 1984 and 1985 is attributed to higher consumption in the summer caused by weather conditions. Timmins often experiences higher summer temperatures than Southern Ontario. Winter consumptions showed little change over the three years, indicating that leakage in the distribution system did not increase and played no role.



TIMMINS WTP
MOE – WPOS
PLATE 1

SECTION C - PROCESS COMPONENTS

C:1 General

C:1.1 Basic Process

The Timmins plant employs the conventional treatment processes consisting of screening and pre-chlorination of raw water, addition of coagulants, mixing, flocculation, settling and filtering, followed by post-chlorination and pH control. Figure 3 presents the Process and Piping Diagram, Figure 4 the Chemical Feed Diagram, and Figure 5 the Block Schematic. A simple Flow Diagram is shown as Plate 1 on the opposite page.

C:1.2 Parallel Treatment

It has been mentioned earlier that there exist two parallel pre-treatment and filtration processes, each with the same capacity. The two processes share a common intake, a raw water well with low lift pumps, and a rapid-mix tank.

The 1972 plant employs process equipment mostly supplied by Neptune-Microfloc while the 1985 addition incorporates treatment equipment supplied by Degrémont. This is indicated on Figure 5, the Block Schematic, and on Figure 3, the Process and Piping Diagram. Both processes produce an almost identical quality of finished water and require very much the same degree of pretreatment. The main difference is in operation. The Neptune-Microfloc process incorporates paddlewheel flocculators followed by rectangular clarifiers with chain and flight type sludge collectors. The filters are of the multi-media type, consisting of anthracite, silica sand, and very fine (.1 mm) high density ilmenite. The Microfloc process can be subjected to considerable flow variations and, if necessary, overloaded to 150% of rated capacity, with virtually no ill effects. The newer Degrémont process on the other hand combines flocculation and

clarification in one tank, the Pulsator, and is followed by dual media (anthracite and sand) type filters. This pretreatment process requires skill to operate because a sludge blanket must be maintained at all times. The blanket is sensitive to flow and temperature fluctuations and periodically requires adjustment of the raw water alkalinity as well. Consequently, the Degrémont process cannot be overloaded without a serious degradation in pretreated water quality. The advantages of the process are that smaller tank areas can be used, that no mechanical equipment is required in the pretreatment tanks and that a reduced quantity of backwash water is needed due to the air scour feature of the filters. These advantages are somewhat offset by a relatively large quantity of pretreatment sludge produced because the blown-off surplus sludge has a lower solids content than does the sludge from the Neptune-Microfloc units.

The Degrémont pretreatment tankage, which places flocculation in the lower portion of the upflow tanks and clarification in the upper portion, occupies approximately 60% of the building area required by the Neptune-Microfloc pretreatment process, where horizontal flow-through takes place. Consequently, construction cost and building heating costs are much lower. Operational costs are comparable, however, there is more expertise required and the pretreatment process is less "forgiving".

C:1.3 Flow Control

On-site storage of filtered water totals 13,500 m^3, which constitutes an average of 8 to 14 hours of production. High lift pumpage into the distribution system is automated to respond to variations in water level of the elevated storage tank. The relatively high on-site storage capacity provides ample time for the plant to follow the fluctuations in demand. Thus the production rate requires only minor adjustments periodically to maintain the clearwells at near full position. Such adjustments are made manually.

C:1.4 Automation

The plant is operated on a 3 shift, 24 hour basis. The following processes are completely automated:

- Flow pacing of chemical feeds.
- Backwash sequence for each filter, after manual initiation.
- High lift pump response to elevated tank level variations.

C:2 Design Data

C:2.1 Capacity

The nominal rated capacity of the plant, as listed on the Certificate of Approval, is 54.6 ML/d, which figure is determined by the rated capacity of the six filters. Of the four almost identical low lift pumps of approximately 25 ML/d capacity each, any one can be out of service, leaving more than sufficient pumping capacity to supply the process. The combined capacity of the electrically driven high lift pumps #4, #5, #6 and #8 is estimated at 70 ML/d. With the largest electrical unit out of service, the firm capacity is 50 ML/d. Starting any of the three engine driven pumps will assure high lift pumping capacity in excess of the rated plant capacity.

During a power outage, emergency power for the entire process, including all low lift pumps, is supplied by two diesel generators. The high lift electrical pumps and the building heating are not connected to emergency power. The combined capacity of the three engine driven high lift pumps is 55 ML/d.

The above definitions of available capacity under various circumstances illustrate that there does not exist any particular bottleneck that could restrict the plant output to less than its rated capacity.

C:2.2 Capacity Variations and Restrictions

The maximum hydraulic capacity of the plant could, in an emergency, be boosted above the rated plant capacity if the Neptune-Microfloc filters were subjected to higher than design rates. These units have produced up to 50% more than design capacity, with very little loss in quality of water produced. This would increase plant capacity to 68 ML/d.

Prior to 1984, abnormal low river water levels combined with hydraulic losses through the intake pipe caused restrictions in low lift pumping capacity. However, modifications made during 1984, consisting of a new and larger intake pipe, combined with a lower setting of the low lift pumps, have eliminated all seasonal restrictions.

Quality variations in the raw water may cause occasional difficulties in operations. In general, such problems are quickly resolved and do not affect or restrict the production rate.

The City's distribution system no longer affects the output of the plant. Prior to 1985, pumping from the plant towards the centre of the Town under maximum demand caused relatively high friction losses. Since that year, a new large diameter transmission main has come into service in anticipation of the scheduled supply by the Timmins WTP to the Whitney-Tisdale community in 1988. This new transmission main has decreased the West to East friction losses and improved the output of the high lift pumps.

C:3 Process Component Inventory

C:3.1 Intake

A concrete intake chamber, 1.5 m wide by 5.0 m long and extending to approximately 2.0 m below water level, was constructed on the south shore of the Mattagami River in 1924. The chamber is

protected by steel sheet piling and projects some 10 m beyond the river bank. It terminates in water with a depth of 2.5 m. The width of the river between banks in that location is 70 m and the depth past the intake increases to 4 m. There is a good current past the inlet and the location, with respect to collecting the best quality water, is excellent. The structure contains twin screens, 1500 mm x 2000 mm, consisting of bars spaced at 75 mm and covered with 25 mm wire mesh. A hoisting frame complete with block and tackle facilitates lifting. Access to the intake structure in the winter is difficult, but the need for cleaning of screens at that time does not exist.

The headworks are followed by a 65 m long, 1500 mm diameter concrete intake pipe leading to the raw water well. This pipe was constructed in 1984. The calculated draw-down for the complete intake works at 54.6 ML/d flow is 50 mm.

The present intake functions very well under all conditions. Icing, or frazil ice formation has never been reported. Consequently, the plant has no provisions for backflushing of the intake.

Chlorine solution for pre-chlorination is normally added into the intake pipe at a distance of 50 m upstream of the raw water well. This provides for approximately 5 minutes of contact time in the pipe at the average flow of 25 ML/d, plus a few more minutes in the raw water well. Good dispersion is obtained by means of the diffuser type solution discharge and the considerable length of intake pipe. The present arrangement is an improvement over the original one whereby chlorine was applied into the raw water well, at the mouth of the intake pipe. It has eliminated previous problems of chlorine gas coming out of solution and corroding copper and other metals in the raw water pump room. The original application point is still available as standby.

The only disadvantage of the early chorine application point is that raw water collected by the raw water sampling pump in the raw water well is already chlorinated and cannot be used for

bacteriological sampling. If Timmins should participate in the DWSP, this arrangement would not be acceptable.

The location of the intake is considered good, but not ideal. The upstream reach of the river is little used for recreation, but the urban area is growing, particularly along the north shore and now extend some 6 km upstream of the plant. Minor chemical spills have occurred, and contaminated stormwater runoff can only increase. Malette Waferboard Industries, located some 15 km upstream, has already been discussed in Section A:1.

C:3.2 Raw Water Well and Screening

The intake terminates in a raw water well that provides for a water depth of approximately 1.5 m at average river levels. To eliminate vortexing and air drawn into the low lift pump suctions at low river water level, the well floor has been deepened under each pump suction by a 1.0 m deep sump.

Manually removable twin screens, 1400 mm wide by 1800 mm high, and covered with 12 mm stainless steel square mesh are provided at the entrance to each half of the raw water well. An electric hoist and wash bay are available for cleaning.

C:3.3 Low Lift Pumping

Description

The raw water well is a narrow concrete structure of 1.4 m x 17.2 m dimensions with a water depth of 1.5 m and 1.0 m deep sumps under each pump suction. There are four vertical turbine type low lift pumps:

Pump No.	Capacity L/S	Capacity ML/d	Head m	Type	kW	Speed rpm	Manufacturer
1	300	25.9	7.8	Vert. turb.	37.5	900 var.	Cascade 14 MF
2	300	25.9	7.8	Vert. turb.	37.5	900 var.	Cascade 14 MF
3	303	26.1	7.8	Vert. turb.	37.5	1200	Cascade 12 H
4	303	26.1	7.8	Vert. turb.	37.5	1200	Cascade 12 H

Discussion

Because friction losses are low and pump performance curves relatively steep, it is estimated that the combined capacity of the pumps is 104 ML/d and the firm capacity (largest unit out of service) is 78 ML/d.

Pumps No. 3 and No. 4 are manually controlled. Units No. 1 and No. 2 are speed controlled according to the level of the pretreatment tanks. All four pumps can be simultaneously driven by the standby power diesel generator.

Raw water flow is measured and the flow signal is used for pacing chemical feeds. Raw water mains consist of concrete cylinder pressure pipe. There are two mains, one leading to the original Microfloc plant, the second to the newer Degrémont plant.

C:3.4 Mixing

The raw water main to the 1972 plant contains an in-line flash mixer, shown in photograph #5. This raw water main and mixer are now strictly standby. The 1985 plant contains a concrete rapid-mix tank of 3.2 m x 3.2 m x 4.4 m depth. This tank now supplies both plants under all flow conditions. Retention time is 1.2 minutes at 54.6 ML/D. The tank has four vertical baffles to promote better mixing and contains a mixer with upper and lower impellers. Bridge and motor gear reducer are shown in photograph #6.

Equipment details are:

* In-line mixer - Lightnin 16-LBC-10, 3.75 kW motor, 1750 rpm;
* Rapid mix - Lightnin FM-50, 3.75 kW motor gear reducer, twin impellers rotating at 81 rpm.

The velocity gradient in the rapid mix tank, calculated by $G = (P/uV)^{\frac{1}{2}}$ is 252 sec^{-1} at 10°C water temperature. In this formula:

P = power dissipated - Watts
V = tank volume - m^3
U = absolute viscosity of water - Pa.sec

The rapid-mix tank has 2 overflow weirs, on opposite sides and extending the full wall length. Overflow from the tank falls down approximately 100 mm, collects in a weir box, and is directed to each of the two pretreatment processes. Weirs, weir boxes and channels are amply sized, so that velocities and shearing effects are kept to a minimum. Likewise, a system of multiple ports introduces the mixed water into the Microfloc flocculation tanks at low velocity (1.0 m/sec. at rated capacity) and at negligible hydraulic head loss. Entry into the Pulsators is via one 450 mm diameter pipe to each vacuum chamber, at the same low velocity.

C:3.5 Flocculation

The 1972 Microfloc plant contains two 10.2 m x 6.15 m x 3.35 m deep concrete tanks, operated in parallel. Each tank contains two shafts fitted with four paddlewheels, as shown in photograph #7. The two shafts are driven by a common gear motor of 1.1 kW. The detention time at the design flow of 27,300 m^3/d is 22 minutes. The velocity gradient is 45.1 sec^{-1}, based on the formula given in the previous section.

The 1985 plant combines flocculation and settling in two Degrémont Super Pulsator tanks. Each tank is 16.0 m x 7.7 m x 4.22 m deep and is fitted with perforated 250 mm diameter distribution pipes at 1000 mm centres in the bottom. Plates of 2.1 m length, spaced at .33 m and inclined 60°, are attached between the sidewalls of each tank, between the distribution pipes and the perforated collector pipes immediately below the water surface. Detention time is 55 minutes and the upflow rate is 4.6 m/hr at the design

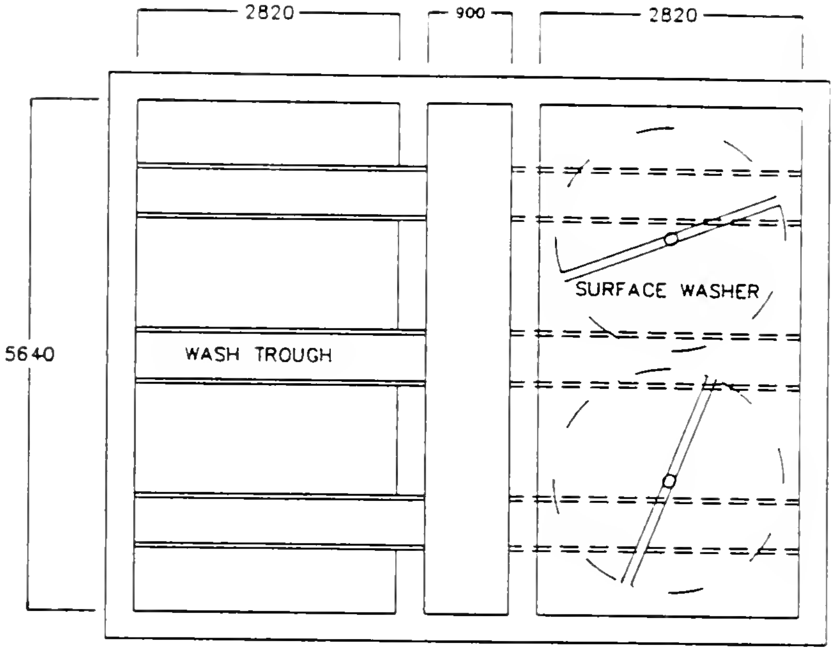
flow of 27,300 m^3/d. Pulses are created by a vacuum chamber at the inlet end of each tank. A vacuum blower evacuates the air over the chamber and a timer actuated valve breaks the vacuum at 30 - 60 second adjustable intervals. Each vacuum blower is driven by a 2.9 kW motor. The vacuum blowers and vacuum breakers are illustrated on photograph #15. The pulses create high velocity water jets between the perforated inlet piping system at the bottom of the tank and assist in the flocculation.

C:3.6 Sedimentation

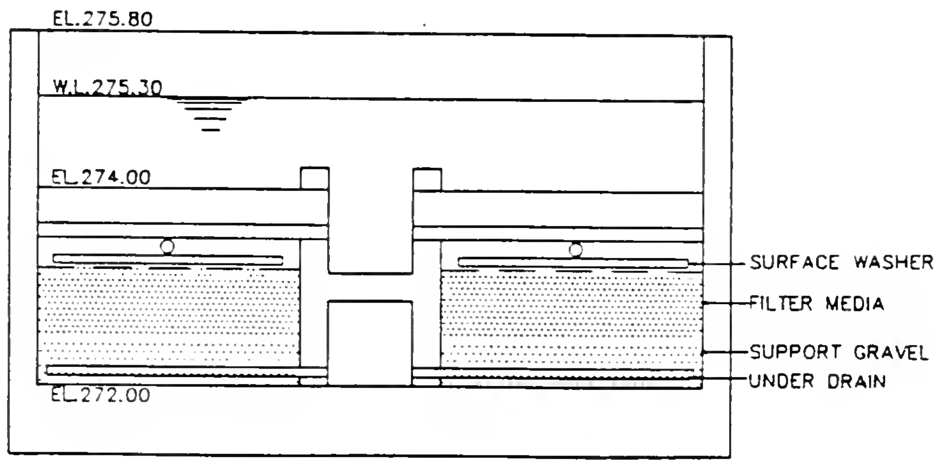
The Microfloc flocculators are followed by two 16.3 m x 6.15 m x 3.35 m deep rectangular clarifiers, equipped with tube settlers and chain and flight type sludge collectors. At design flow, the detention time is 35 minutes and the upflow rate is 5.6 m/hr. The tube settlers can be seen on photograph #8. Effluent is collected by means of perforated pipes immediately below the water surface, covering the full area over the tube settlers.

The Degrémont Pulsators contain a sludge blanket extending to approximately 2.5 m above the tank floor. The upper limit of the blanket is generally clearly defined. The 1.7 m water depth over the blanket is used for clarification. The top portion of the blanket spills over into a trough along the side wall of the tank. The inclined plates extend to approximately .4 m above the blanket, and being spaced at .3 m intervals, do not act as plate or tube settlers but more to promote the flocculation and growth of the floc particles and to prevent currents inside the sludge blanket. Clarified effluent is collected by means of perforated pipes directly below the water surface. As mentioned earlier, the upflow rate is 4.6 m/hr at design flow.

The clarified water collected by the perforated collection pipes flows is discharged into open concrete channels extending the full length of each settling tank. The channels for the Microfloc settling tanks join into a common filter feed channel supplying the Microfloc filters. Likewise, the Degrémont Pulsator



PLAN



SECTION

MICROFLOC FILTER

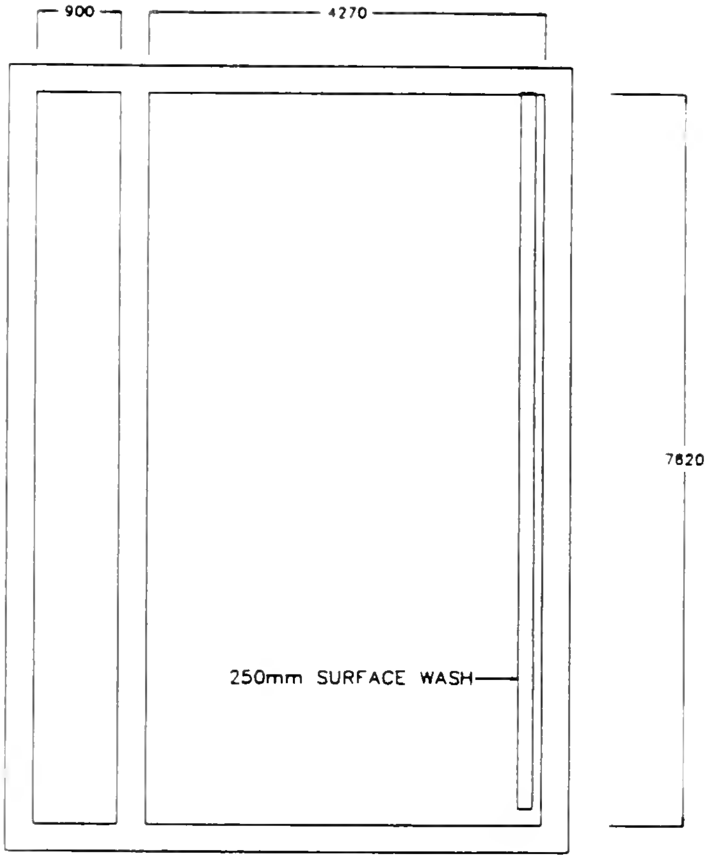
TIMMINS W
MOE — WP
PLATE 2

collection channels come together into one filter feed channel for the Degrémont filters. All channels are designed for velocities of about 1.0 m/sec. at design flow.

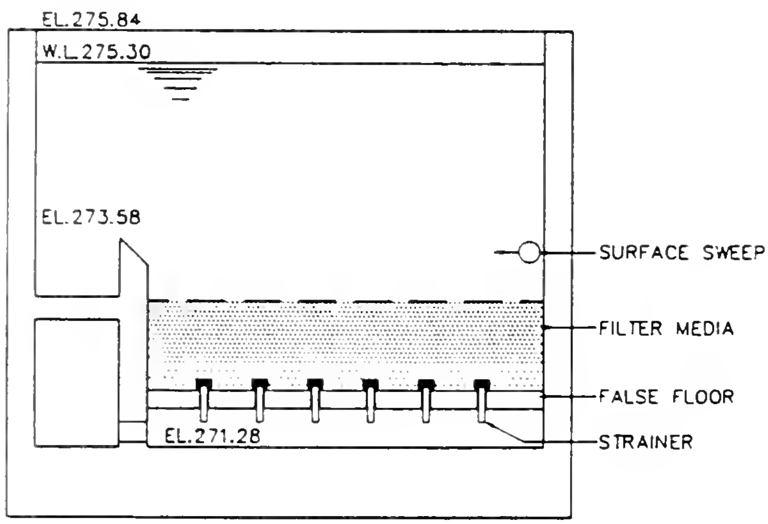
C:3.7 Filters

C:3.7.1 Filters #1, #2 and #3 (Microfloc)

Dimensions	Refer to Plate 2, opposite page.
Construction	Open concrete tanks, constructed in 1972
Type	Centre gullet, with filter box on each side
Media	Anthracite 400 mm SG 1.5 Silica sand 250 mm ES 1.5 mm SG 2.6 Ilmenite 80 mm ES 0.1 mm SG 4.5
Support gravel	High density 75 mm SG 4.2 Graded silica 375 mm, 4mm to 20 mm SG 2.5
Underdrains	100 dia. perforated AC pipes @ 300 mm centres
Filter area	95.3 m^2, total for 3 filters.
Filter rate	11.9 m/hr at design flow of 9100 m^3/d per filter
Filter production	200 m^3/m^2 average (24 hr run at 70% capacity)
Max. backwash rate	43 m/hr
Normal backwash rate	36 m/hr (summer) to 26 m/hr (winter)
Backwash volume	7.2 m^3/m^2 (summer) to 5.2 m/m^2 (winter)
Wastage	3.6% average
Surface washers	4 units per filter
Valving	Raw water influent 450 sq. sluice gate Backwash drain 450 sq. sluice gate Filter-to-waste 100 dia. butterfly valve Effluent rate controller 300 dia. butterfly valve Backwash 400 dia. butterfly valve Surface wash 75 dia. globe valve
Instrumentation	Filter rate controller for each filter with master control for 3 filters Flow and headloss recorder for each filter Cam timer for auto backwash sequence Backwash flow rate controller serving 3 filters Backwash flow meter and totallizer



PLAN



SECTION

DEGRÉMONT FILTER

TIMMINS W
MOE - WPO
PLATE 3

C:3.7.2 Filters #4, #5 and #6 (Degrémont)

Dimensions	Refer to Plate 3, opposite page.
Construction	Open concrete tanks, constructed in 1984
Type	Side gullet, with adjacent filter box
Media	Anthacite 500 mm ES 0.85-0.90 SG 1.5 Silica sand 250 mm ES 0.45-0.55 SG 2.6
False Floor	Precast concrete slabs, complete with plastic strainers
Filter area	97.6 m^2, total for 3 filters
Filter rate	11.6 m/hr at design flow of 9100 m^3/d per filter
Filter production	195 m^3/m^2 average
Max. backwash rate	43 m/hr
Normal backwash rate	19.2 m/hr approx.
Backwash volume	3.2 m^3/m^2 approximately winter and summer
Wastage	1.6% $\pm$ approx.
Surface sweep	250 dia. perforated pipe gravity fed by pretreated water
Air scour blower	30 m^3/hr @ 30 kPA centrifugal blower with 37.5 kW motor
Valving	Raw water influent 450 sq. sluice gate Backwash drain 450 sq. sluice gate Filter-to-waste 100 dia. butterfly valve Effluent rate controller 250 dia. butterfly valve Backwash 400 dia. butterfly valve Surface sweep 250 dia. butterfly valve Air scour 150 dia. butterfly valve
Instrumentation	Filter rate controller for each filter with master control for 3 filters Flow and headloss recorder for each filter Programmable controller for auto backwash Backwash flow rate controller serving 3 filters Backwash flow meter and totallizer

C:3.7.3 Discussion

Influent turbidity is not monitored. Effluent sample pumps at each filter send filtered water to the laboratory, where turbidity is measured for each filter at four hour intervals. Backwash is initiated manually when effluent turbidity exceeds 0.9 FTU or at approximately 24 hour intervals, whichever comes first. Presumably, a lower value could be used as the threshold turbidity, however, this would increase the backwash frequency. Filter headloss is recorded, but not normally used as an indicator for starting backwash because effluent quality is of paramount importance. Filter backwash flow is metered and totallized. Filter flow is continuously recorded, but not totallized.

An interesting feature of the Degrémont filters #4, #5 and #6 is the absence of troughs collecting spent backwash water over the media. Instead, a surface sweep pipe at the side of each filter sends pretreated water from the filter influent channel by gravity across the surface of the backwashing filter. The horizontal velocity is insufficient to clean the media but directs scum and spent backwash water to the backwash channel. Another good feature is the discharge of the filter-to-waste pipe into the filter box above the water, thereby returning or recycling already pre-treated water.

Filtration rates are set manually. The rate is kept constant by the rate controller under varying headloss conditions. Rates are adjusted infrequently, because of the relatively large storage capacity in the clearwells.

A question has arisen as to possible concern about the asbestos-cement underdrains in filters #1, #2 and #3 being attacked by aggressive water. It is not easy to inspect these drains, and since they are still functioning well after 15 years, it is assumed that they are still in good condition. However, it is recommended to sample and test for asbestos, since lost fibres would enter the distribution system directly.

The surface of the anthracite in the Microfloc filter boxes is monitored from time to time, and anthracite losses from wear and tear and carry-over are made good. Sieve analysis and grain size characterization is not practised.

C:3.7.4 Filter Backwash

The single backwash pump, serving all six filters, is a double suction horizontal pump, Aurora Model 411-OJ, with a capacity of 380 L/s @ 9.1 m TDH and 56 kW, 1200 rpm motor. Photograph #13 refers.

There is one backwash rate controller for each group of 3 filters. This assembly permits the backwash rate valve to open and close at controlled rates. The entire backwash sequence is automated, with adjustable settings for duration of backwash, air scour, filter to waste and surface washers. The Degrémont filters, which are scoured by air before the water backwash begins, require a much lower backwash rate than the Microfloc filters.

Backwash flow rates for the Microfloc filters are increased somewhat when water temperatures go up in the summer. This increase is in the order of 20%. The duration of the backwash is determined by visual judgement of the clarity of the backwashed surface, as observed by the operator. A backwash sequence has no effect on the operation of other filters in the group of 3, other than that only one filter can be washed at a time.

C:3.7.5 Emergency Backwash

Emergency backwash, in case of service to the backwash pump, can be accomplished by means of a hydraulically operated 200 mm diameter ball valve on a 300 mm diameter branch of the distribution system, reducing the 850 kPa system pressure to the pressure needed for the desired flow. The ball valve can be opened at a very steady and slowly controlled rate, until the backwash flow meter indicates the desired flow rate has been

established. The valve is then maintained in the last position until the backwash is completed. It has rarely been used. The method is considered perfectly safe, provided the operator is properly instructed. A special key is required to operate the valve in order to prevent accidental opening because an uncontrolled opening could cause serious damage to the media.

C:3.7.6 Transfer Pumps

Transfer pumps are connected to the filtered water outlet of of each filter to lift the water to the level of the clear wells. These pumps were selected on the basis of flat performance curves in order to produce with reasonable efficiency against the varying heads produced by increasing filter head flow and adjustable rate valve settings. The pump output is measured by the Annubar on the rate controller, and the control valve modulates to maintain the desired filter flow. All filters are rated at 105 L/s. In the expectation that especially the Microfloc filters could produce well above rated capacity, the corresponding transfer pumps were selected to permit a 60% filter overload.

* 1972 transfer pumps - 3 Warren PL end suction, rated 170 L/s @ 6.1 m TDH, 15 kW, 720 rpm motor;
* 1985 transfer pumps - 3 Worthington 8FRBH-182 end suction, rated 132 L/s @ 6.6 m TDH, 15 kW, 900 rpm motor.

C:3.7.7 Filter Gallery

Filter gallery piping is thin walled stainless steel with welded joints. Photograph #9 illustrates the 1972 plant and photograph #10 the 1985 plant. All control valves are pneumatically activated.

C:3.7.8 Blending Chamber

The streams produced by the two plants join in the upstream portion of the blending chamber. At this point, post-chlorine, lime and zinc polyphosphate are added. A dividing baffle creates

the turbulence required for dispersing the chemicals and for blending the two streams before the finished water is piped to the clearwells.

C:3.7.9 **Clearwells**

Four ground level concrete tanks, with the same floor elevations and water depths can be independently operated by means of sluice gates on entrance and outlet sumps. The tanks are baffled to eliminate dead areas and have slightly sloped floors to facilitate washing down. The total volume is 13.5 ML. Tanks No. 1 and No. 2 are each 2250 m^3 in volume, while tanks No. 3 and No. 4 have a volume of 4500 m^3.

The configuration of the tanks on the site is shown on Figure 2. The general baffling arrangement and interconnecting pipe lines are illustrated on Figure 3. The retention time at design flow is 2 hours when tanks No. 1 and No. 2 are in use, which is the case if high lift pumps No. 4, No. 5 or No. 6 are in operation. The retention time is 4 hours at design flow when high lift pumps No. 7 or No. 8 are used.

The only instrumentation for the tanks is one level transmitter and recorder. The level transmitter can be manually connected to each of the 4 tanks by means of a 4 valve manifold.

C:3.8 **High Lift Pumps**

The high lift pumps are arranged in two pump rooms. The older and largest one is the original Hollinger pump house (photographs #11 and #12) containing five pumps and a generator. A new pump room (photograph #14) houses pumps #7 and #8. All pumps are of the split-case, double suction type. All units take suction from a common header in the pump room, which is fed directly by one of the clearwells. Similarly, each group of pumps discharge into one common header or manifold. In the list of pumps below, it should be noted that #3 is missing; this is because it was removed in 1972 and its base used for a diesel generator.

#1: Babcock-Wilcox, 2-stage, 15.7 ML/d (182 L/s) @ 88 m TDH, driven by 300 kW, 1800 rpm diesel engine;

#2: Babcock-Wilcox, 2-stage, 10.8 ML/d (125 L/s) @ 88 m TDH, driven by 300 kW, 1800 rpm diesel engine;

#4: Allis-Chalmers, double suction, 10 x 8 SJD, 16.3 ML/d (189 L/s) @ 88 m TDH driven by 225 kW, 1800 rpm electric motor;

#5: Warren, double suction, 10-DLB25, 20.9 ML/d (242 L/s) @ 88 m TDH, driven by 300 kW, 1800 rpm electric motor;

#6 Warren, double suction, 10-DLB25, 24.4 ML/d (283 L/s) @ 88 m TDH, driven by 300 kW, 1800 rpm electric motor;

#7: Patterson, 12 x 10 MAA, 34.6 ML/d (400 L/s) @ 77 m TDH, driven by Harper Detroit, 1800 rpm diesel engine;

#8: Patterson 12 x 10 MAA, 23.9 ML/d (277 L/s) @ 88 m TDH, driven by 300 kW, 1800 rpm, electric motor.

The combined capacity of the electric pumping units #4, #5, #6 and #8 is estimated at 70 ML/d. With either #6 or #8 out of service, the firm capacity is estimated at 50 ML/d. Combined diesel driven pump capacity of #1, #2 and #7 is estimated at 55 ML/d. The combined capacities were estimated by adding up the reduced outputs of the pumps under the increased head conditions resulting from maximum flow.

Discussion

The selection of diesel engine driven high lift pumps to provide standby service in case of power failure rather than a large generator in the "old" plant was dictated by the presence of existing engine driven pumps #1 and #2. For the "new" plant, the choice was based on a cost comparison for two systems, which showed that one very large generator, suitable to drive two electric pumps (#7 and #8), would not be cost effective when compared with the cost of one engine driven pump, one electric pump and one small generator.

The electric pumps all have Hands-Off-Automatic control switches in the main control room. Under Automatic control, the level in

the elevated tank governs the stopping and starting of any two pumps in sequence.

To control undesirable pressure variations during stopping and starting, all electric pumps are equipped with hydraulically operated, slow opening and closing check valves.

C:3.9 Backwash Treatment and Sludge Disposal

C:3.9.1 General

The following section describes the existing facilities available for waste treatment and disposal. As part of the Optimization Study, a separate report entitled "Water Plant Waste Study" is to be prepared to study the efficiency of the present methods, and to recommend modifications or alternatives.

C:3.9.2 Sludge Blowdown

The surplus sludge from the Microfloc settling tanks and from the Degrémont Pulsator is directed to the wet well of a sewage pumping station that sends the sludge via a 560 m long, 150 mm diameter force main to the municipal sanitary sewer system. The station is equipped with 2 Barnes model 4 SEH 505 submersible pumps, rated 19.0 L/s @ 11.8 m TDH, 3.75 kW, 1800 rpm.

The Microfloc settling tanks chain and flight sludge collectors scrape settled sludge to a hopper, one for each of the two tanks. The two Degrémont Pulsators collect surplus sludge when the top of the sludge blanket spills over into a trough, divided in 3 sections along the full length of one Pulsator tank. Thus there are a total of 6 Pulsator trough sections and 2 Microfloc settling tank hoppers that require to be blown off periodically. This is accomplished by 8 pneumatically operated valves that open in sequence on a time cycle. A separate control panel is provided, with one master timer to initiate sequences, and 8 individual timers, that govern the "open" duration for each valve.

As discussed in subsection B:2.2, the sludge blowdown quantities which could not be measured have been estimated as follows:

Auto desludging Microfloc:	96 min/day x 2.7 m^3/min =	259 m^3/d
Manual desludging Microfloc:	30 min/day x 4.0 m^3/min =	120 m^3/d
Auto desludging Degrémont:	288 min/day x 2.7 m^3/min =	778 m^3/d
TOTAL SLUDGE BLOW OFF		1157 m^3/d

C:3.9.3 Filter Backwash

After an evaluation of the receiving stream by M.O.E. in 1984, it was decided that filter backwash be returned to the river without any treatment, via an existing drain discharging 50 m downstream of the intake.

C:4 Chemical Systems

C:4.1 General

All chemical feed systems can be manually or automatically controlled. In the latter mode, dosage is proportional to raw water flow. Raw water can be conveyed through either of two raw water mains. Both are metered. The older main leading to the Neptune plant and in-line flash mixer is strictly a stand-by facility. The newer main and rapid mix tank are now always used, and so is the new raw water meter, which provides the signal for all chemical feeders. For ease of understanding the various chemical feeding points, reference should be made to Figure 4 - Chemical Feed Diagram. Chemical piping consists almost universally of flexible polyethylene piping, bundled together and laid in trays or solid raceways. This eliminates the need for insulation against condensation, and permits easy modifications, rerouting, or replacement.

C:4.2 Chlorination Facilities

Chlorination facilities consist of equipment for handling and indoor storage of up to 10 one tonne containers, two weigh scales and two chlorinators. The latter two are Wallace & Tiernan V-800 units, equipped with rotameters each capable of a dosage of 135 kg/day maximum. Dosage control is by electric plug positioner controlled by a 4 - 20 MA signal from the raw water meter. The dosage range generally is between 1 and 3 mg/L. The maximum dosage each chlorinator is capable of supplying under design flow conditions of 54.6 ML/d is 2.47 mg/L. The equipment is shown in photographs #17 to #20.

Summer operation under normal conditions consists of using one container and one chlorinator for pre-chlorination, and using the second set for post-chlorination. Winter operation or operation during maintenance consists of using one cylinder and one chlorinator, with chlorine solution flow splitting through a one-in, two-out rotameter panel. Taste and odour problems with raw water sometimes necessitate higher pre-chlorination dosages.

Feeding points for pre-chlorination are at the intake headworks or into the raw water well. The former is preferred and the latter is regarded as standby. For post-chlorination, the solution is fed to the blending chamber.

C:4.3 Aluminum Sulphate

Aluminum sulphate is delivered in bulk and stored in a translucent fibreglass liquid alum storage tank built into the basement of the building. Feeding facilities consist of two double headed metering pumps. One is a duty pump, the second one is standby. Both pumps have a variable speed drive motor that receives a 4 - 20 MA signal from the raw water flow meter that is in service at the time. Alum can be fed either into the raw water main serving the 1972 plant (immediately upstream of an in-line mixer) or into

the inlet pipe of the rapid mix tank of the 1985 plant. The latter normally supplies both plants.

Because one pretreatment process may require somewhat more alum than the other process, a third metering pump has been provided to supplement the alum dosage to either one or the other pretreatment stream. This third pump is manually controlled.

The equipment is illustrated on photograph #21 and can be summarized as follows:

* storage tank for liquid alum - 27 m^3 capacity, fibreglass;
* metering pumps - two Wallace & Tiernan, double headed diaphragm type, Model A-748, maximum capacity 3200 L/d, with variable speed motor drive;
* supplementary feed - 1 - Prominent Model P-AFP, solenoid driven, maximum capacity 500 L/d.

The maximum dosage at design flow for the two main pumps together is 60 mg/L. With a single pump, one pumping head and minimum stroke position, the dosage applied would be less than 0.5% of the maximum.

C:4.4 Coagulant and Filter Aid

The polymer in the form of dry powder used at the present is named Alchem IU50 and is supplied by Alchem Inc. The product is EPA and AWWA approved. Batches are made by dissolving 3.6 kg powder in 1100 L of water, and mixing for several hours. The batch is then transferred by gravity to a feed tank. Two metering pumps (one duty and one standby) paced by raw flow, supply the process requirements. The pump discharge is diluted with a constant flow of water and distributed via small diameter polyethylene piping and valving. Approximately 75% is applied to the rapid mix tank and the remainder to the channels carrying pretreated water to the filters. A typical dosage rate is .10 mg/L for coagulant aid and .03 mg/L for filter aid.

The equipment is shown on photograph #22 and consists of:

* one 1200 L mix tank with mechanical mixer;
* one 1200 L feed tank;
* two metering pumps, Wallace & Tiernan Model A747, capacity 1600 L/d, variable speed motor driven.

The two pumps together can supply 0.2 mg/L for coagulant and filter aid combined under conditions of maximum flow.

C:4.5 Lime for Alkalinity Control

Alkalinity control of raw water has been found beneficial to maintain the sludge blanket in the Degrémont Pulsator.

Lime for alkalinity control of raw water is provided by a dry chemical feeder that distributes the powder in a continually mixed slurry tank. From here an ejector dilutes the slurry and feeds it to the rapid mix tank, at the weir leading to the Pulsator tanks. Thus the Microfloc pretreatment process, which does not depend on a sludge blanket for pretreatment, does not receive alkalinity adjusted raw water.

The equipment is shown on photograph #23 and consists of:

* one Wallace & Tiernan Model A-690 dry chemical feeder, 1.3 m^3/d capacity, variable speed motor driven.

The maximum feed rate at design flow would be 10 mg/L. Actual rates are in the order of 1-2 mg/L.

C:4.6 Lime for pH Control

Lime for pH control of finished water is supplied in bulk and stored in a silo. It is manufactured by Domtar, to AWWA specifications. A batch feeder under the silo periodically fills a bin mounted over a dry chemical feeder. The batch feeder is

activated by limit switches inside the bin and releases batches of 192 kg each. These batches are counted and provide the daily record of lime fed. Lime slurry is pumped through a rubber hose into the blending chamber where the filtered water streams from the 1972 and 1985 plant come together.

The underside of the silo, the day bin and the slurry pump are shown in photographs #25 and #26. The equipment specifications are as follows:

* silo with aerated bottom, 45 m^3 storage volume (18,000 kg by weight);
* one Wallace & Tiernan Model A-728 dry chemical feeder, 1.7 m^3/d capacity, with variable speed motor paced by raw water flow;
* one Robbins & Myers Model 1L4 Moyno slurry pump, .75 L/s and .5 kW motor.

The dry chemical feeder would permit a maximum feed rate of 13 mg/L under design flow conditions. A range of 15 to 20 mg/L has been found most effective.

C:4.7 Zinc Polyphosphate

Zinc polyphosphate for corrosion control in the distribution system consists of batches made of 4.5 L Alchem 7384 liquid zinc chloride combined with 9.5 kg of Alchem 519 polyphosphate powder, mixed in 1100 L of water, both supplied by Alchem Inc. Batches are mixed for several hours in a mixing tank, then transferred by gravity to a feed tank. The solution is then fed to the blending chamber.

Photograph #24 illustrates the equipment, that consists of:

* one 1200 L mix tank with mechanical mixer;
* one 1200 L feed tank;
* two Prominent Model P-AFP capacity 1300 L/day, solenoid driven and controlled by 4 - 20 MA signal.

Using the above dilution ratios, the two pumps together could supply 0.6 mg/L under design flow conditions. The actual rate is generally just below 1.0 mg/L.

C:5 **Sampling**

All samples for water quality testing are provided by sampling pumps and collected centrally in the laboratory. Samples for the analysis of sludge have to be collected from sampling valves on the sludge blow-off pipes. The list below illustrates the sources, piping details, travelling speeds and travelling times.

LIST OF SAMPLING SOURCES AND PIPING DETAILS

Source	Mat'l.	Dia mm	Length m	Flow L/sec	Velocity m/s	Travel Time min.
Filter effluent No. 1	copper	12	33	.07	.6	.9
2	copper	12	26	.07	.6	.7
3	copper	12	18	.07	.6	.5
4	copper	12	56	.07	.6	1.6
5	copper	12	50	.07	.6	1.4
6	copper	12	45	.07	.6	1.3
Finished water from blending chamber	copper	12	44	.07	.6	1.2
System water from	C.I.	500	60	200*	1.0	1.0
distribution system	copper	12	15	.07	.6	.4
						1.4
Raw water, after prechlorination from						
- standby raw water main	copper	12	30	.07	.6	.8
- active raw water main	copper	12	58	.07	.6	1.6
Raw water, from						
- standby flash mixer	copper	12	30	.07	.6	.8
- active rapid mix tank	copper	12	58	.07	.6	1.6

(*) Quantity, velocity and travel time through 500 mm diameter CI pipe vary with system demands.

The filters are each equipped with a sampling pump. All six sampling lines terminate in a common line in the laboratory. By operating a multi-position selector switch, one sampling pump is selected and one filter at a time can be monitored. This is generally the filter that has the longest run and is slated for the next backwash.

All other sources described, except for system water, are also sampled by means of small pumps, that bring water to the central laboratory. The two raw water sources before the addition of coagulant discharge into a common line, and so do the two raw water sources after coagulant addition. Of course, only one of the two sources is in use at any one time.

Because prechlorination of raw water occurs very close to the headworks of the intake pipe, the raw water sampled before coagulant addition is chlorinated and cannot be used for bacteriological sampling.

Other sources that can be sampled on location via gravity sampling taps are:

* sludge blanket in Pulsator No. 1 at 4 different elevations;
* 3 sludge trough sections in Pulsator No. 1;
* 3 sludge trough sections in Pulsator No. 2;
* 1 sludge discharge pipe for each Microfloc settling tank.

C:6 Automation and Instrumentation

There are strip chart recorders for the following parameters:

* Filters #1 to #6 - Flow and head loss.
* Flows - Raw and finished water.
* Levels - Clear wells and elevated tank.
* Pressure - System pressure.

The following functions can be either manually or automatically controlled:

* Filters #1 to #3 - Auto backwash sequence.
* Filters #4 to #6 - Auto backwash sequence.
* Low Lift Pumps #1 and #2 - Speed control by pretreatment tank water level.
* Two of the 4 high lift pumps - stop/start by elevated tank water level.
* All Chemical Feeders - Paced to raw water flow.

The Annunciator Panel contains visual and audio alarms for a number of conditions, including:

* High and low pretreatment tank water level;
* High and low clear well;
* High and low elevated tank;
* High filter head loss.

C:7 **Stand-by**

Two emergency power diesel generators are available:

* #1 200 kW (1972)
* #2 200 kW (1985)

When both units are running, power is available for all low lift pumps, transfer pumps, air compressors, motorized valves, chemical feeders controls and lights. Thus the entire plant can operate normally, except for building heating and for electrically driven high lift pumps. Diesel pumps #1, #2, and #7 jointly can produce the rated plant output of 54.6 ML/d. These pumps would then have to be manually controlled.

SECTION D - PLANT OPERATION

D:1 General Description

D:1.1 General Operation

It is the City's policy to have the plant attended on a 24 hour basis. Consequently, the level of automation is limited and reliance is placed almost exclusively on manual control.

Virtually all control functions are centered into one plant operating panel (photograph #2). The control room also contains the plant laboratory and sampling sink.

D:1.2 Staffing

Staffing requirements are somewhat complicated on account of the fact the same personnel complement is responsible for the operation of the 3 City water supply systems. Considerable time is devoted to the operation of the Whitney-Tisdale system, with its many wells, pumps, chlorinators and acquifer recharge requirements as well as to the Buffalo-Ankerite surface water filtration plant.

Attendance at the Timmins plant generally consist of two operators during the day shift, and one operator for the two remaining shifts. The Chief Operator has an office at the Timmins plant, and is fully responsible for the day to day operations of all supply systems as well as the City's water metering section. There are 6 operators working directly under the Chief Operator.

D:2 Flow Control

D:2.1 Low Lift Pumps

There are 2 manually controlled constant speed and 2 variable speed vertical turbine low lift pumps, each rated 26 ML/d.

Frequent demands are in the 20 to 30 ML/d range. Demands of less than the capacity of one pump are met by one of the variable speed units, while demands in excess are met by one constant and one variable speed pump.

The variable speed pump output is automatically governed by the water level of either of the two pretreatment plants. Accordingly, the raw water flow is adjusted automatically.

D:2.2 **Sedimentation and Filters**

Filters are supplied by gravity through a system of open channels by the sedimentation tanks. Because channel velocities are low, hydraulic losses between pretreatment units and filters are negligible, and an almost common water level exists for filters, settling tanks and flocculator tanks. This combined tankage has a large surface area, and sudden flow decreases (taking a filter out of service for backwash) or sudden flow increases (filling an empty filter after backwash) cause little variation in the water level of the combined tanks. Consequently, raw water flow changes are very minor and the pretreatment process can continue at a very steady pace.

The plant filters are arranged in two groups of 3 units. Each group has a common rate setting device, which ensures that the controller for each filter maintains the same flow as the other filters in the group. lt is the duty operator's responsibility to make minor adjustments to the master controller from time to time to maintain the clearwell at a reasonable level, i.e. between 70 and 100% full.

D:2.3 **High Lift Pumps**

All 4 high lift electric pumps are equipped with H.O.A. selectors located in the plant control panel. A master selector switch in the same central plant gives a choice as to which two of the 4 pumps are to constitute the lead and lag pump, to be stopped/started by the level in the elevated tank which is situated some 3 km distance from the treatment plant.

In general, one pump operates continuously, and a second one cycles on and off to meet the fluctuations in demand.

Because of the relatively high storage capacity at the plant, hourly variations in demand do not affect the plant's production rate.

D:3 Disinfection Practises

Chlorine is used for pre- and post-chlorination. Typical average dosages are 2.5 and 1.5 mg/L. The highest prechlorination generally takes place during the months of April, May and June, to combat taste problems that tend to occur during these periods.

Prechlorination was formerly applied in the raw water well. Dispersion was not always immediate and uniform, and corrosion of the fine screens and low lift pumps in this well was severe. Also, some gas tended to escape and cause corrosion in the low lift pump room. Consequently, the chlorine solution is now directed to a point directly downstream of the river intake, and 50 m upstream of the raw water well. Dispersion is good, and no more corrosion problems have been reported.

Post-chlorination takes place in the blending chamber, when the streams of filtered water from the two plants join and are distributed to the clearwells.

Chlorinated raw water and system water is sampled from the continuously running sampling taps in the laboratory and analysed for free residual chlorine by the duty operator every hour. The aim is to maintain a residual of 0.5 mg/L. In case of variance, the dosage control on the chlorinator is manually adjusted by the operator.

D:4 Operation of Specific Components

D:4.1 Intake

The intake works require little maintenance. The coarse bar screen can be observed from the surface and requires only occasional removal of pieces of wood or debris. The pair of 30 mm mesh screens inside the intake structure is lifted out 4 times per year, hosed down, inspected and re-inserted. Aquatic weeds and leaves are washed off and left in the grassy surface. From November to March, when the river is ice covered, no cleaning can be done.

Frazil ice, or other icing problems have never been experienced. Consequently, there are no provisions for backflushing.

D:4.2 Screening

There are double screens of 12 mm stainless steel mesh in the raw water well upstream of the low lift pumps. These screens are hoisted out every three months and washed. The wash water is returned to the raw water well, and the screenings collected manually and disposed off as solid waste.

D:4.3 Low Lift Pumping

The 4 vertical turbine pumps require little maintenance, since all pump bearings are water lubricated. The two variable speed motors are of the wound rotor type, with slip rings and carbon brushes. Carbon dust is occasionally removed from the motors, and carbon brushes are regularly inspected for wear.

D:4.4 Mixing and Flocculation

The in-line flash mixer in the stand-by raw water main is no longer in use. It is exercised occasionally to check that it is in working order. The newer rapid-mix tank has no operating features. The mixer is of the fixed speed type, and the chemical

addition points are directly in the mouth of the incoming raw water line.

With respect to flocculation in the Neptune-Microfloc plant, there are no operational features that can be adjusted since the paddlewheel flocculators rotate at a constant speed. The only variable is retention time as a function of flow.

Flocculation in the Degrémont Pulsators takes place in the bottom zone of the tanks, between and immediately under the 250 mm diameter perforated inlet pipes, by the velocity changes of the incoming water that are caused by the "pulsed" supply of chemically mixed water. The interval between pulses can be adjusted by the operator, as discussed in the next section but this has little influence on the flocculation process.

D:4.5 Sedimentation

Sedimentation in the Neptune-Microfloc process takes place in standard settling tanks, equipped with chain and flight type sludge collectors and tube settlers below the effluent collecting piping. These tanks have no operational features.

In the Degrémont Pulsator tanks a sludge blanket must be maintained, and operator experience and judgement is required. The tanks are basically vertical upflow type, with a full area distribution system near the floor, and a full area collection system near the surface. Chemically mixed raw water enters the vacuum chambers where suction blowers evacuate the air until the liquid level in the vacuum chamber is approximately 1.2 m above the Pulsator tank level. Instantaneous opening of the vacuum breaker valve causes the mixed raw water to enter the tank at high velocity through orifices in the perforated distribution pipes, over a period of 1 to 1.5 seconds. During the next 40 to 60 seconds, premixed water refills the vacuum chamber. The highest density sludge is in the bottom of the tank, and the periodic high velocity entrance of the premixed water near the tank bottom maintains the sludge in suspension.

The operator can vary the frequency of the pulses only. A longer interval collects more water in the vacuum chamber, creates a higher differential between the water levels in the vacuum chamber and the Pulsator tank, and upon breaking of the vacuum, imparts more energy by releasing more water at a higher velocity. It will cause the entire blanket to increase its depth.

As the sludge blanket increases in density by the continuing addition of suspended solids, the top of the blanket rises until solids start spilling over into a trough running along the length of one side of the tank. The trough is approximately 1.5 m wide by 1.3 m deep, with a V-shaped bottom sloped at 55°. In the invert is a perforated 150 mm diameter sludge collector pipe. The trough in each Pulsator tank is divided in 3 equally long sections, each with its own independent sludge collector pipe. The 6 sludge blow-off pipes are individually valved, and discharge in the well of the sludge pumping station. Sludge blow-off takes place on a time cycle basis. Operator control consists of varying the intervals between cycles, to increase or decrease the depth of the sludge-blanket and the density of the sludge being blown off.

Inspections of all tanks containing mechanical equipment is done three times per year. Chains and flights are checked for condition and wear. Walls, floors and internals are hosed down. The Pulsator tanks are drained and inspected once per year.

D:4.6 Filters

All filters are operated on the constant flow, increasing head principle. In general, all filters are in service, even during periods of minimum demand. A filter is taken out of service only because of maintenance or repair to one of its components. Consequently, filter flow rates are generally well below the design rates given in subsections C:3.7.1 and C:3.7.2. This method is conducive to the production of the best water quality.

A polyelectrolyte is added to the beginning of the filter influent channel. This filter aid constitutes approximately 25% of the polyelectrolyte stream leading to the rapid mix tank as coagulant aid.

Backwash initiation by headloss is not practised because effluent quality is the guiding criterion. Effluent of each filter can be monitored in the laboratory by switching to the corresponding sample pump. In actual practise, the filter that has had the longest run is sampled mostly. If turbidity is over .9 FTU, or if the filter has been in service over 24 hours, the filter is backwashed. Filter backwash sequences for both plants are automatically controlled, but always manually initiated. Predetermined in each automatic sequence are:

* Air scour duration for the three Degrémont filters;
* Backwash rate valve controlled opening and closing duration for each group of three filters;
* Backwash rate and duration for each group of three filters.

The duration of the backwash is adjusted from time to time by visual judgement of the clarity of the backwash water. The duration for the Microfloc filters generally is 12 minutes in the winter and 10 minutes in the summer; for the Degrémont filters 10 minutes has been found adequate for all seasons.

A detailed description of the Microfloc filter backwash automated procedure is as follows:

1. Influent gate closes, while normal flow rate for filter is maintained for 3 minutes.

2. Filter effluent rate valve closes, transfer pump stops, and drain gate opens.

3. Backwash pump starts and filter backwash valve opens.

4. The backwash rate valve opens at a controlled speed, taking about 30 seconds to establish desired flow rate.

5. Approximately one minute later, when the media are fully expanded, the surface washers start and operate for about 3 minutes.

6. After 10 to 12 minutes of backwashing, the backwash rate valve closes slowly, and backwash pump stops.

7. Backwash valve and drain gate close.

8. Influent gate opens, transfer pump starts and filter-to-waste valve opens for 3 minutes.

9. When filter-to-waste valve closes, filter effluent rate valve opens, and filter is on-line again.

The Degrémont filters are also backwashed automatically. The sequence is as follows:

1. Influent gate closes, while normal flow rate for filter is maintained for 3 minutes.

2. Filter effluent rate valve closes, transfer pump stops, and drain gate opens.

3. Air blower starts and air scour valve opens for 5 minute period.

4. Air scour valve closes and blower stops.

5. Backwash pump starts and backwash valve opens.

6. Backwash rate valve (common valve for 3 filters) opens at a controlled speed, taking about 30 seconds to establish desired flow rate.

7. Surface sweep valve opens to establish flow across the bed towards the drain trough.

8. After 10 minutes of backwashing, the surface sweep valve closes, the backwash rate valve closes slowly, and backwash pump stops.

9. Backwash valve and drain gate close.

10. Influent gate opens, transfer pump starts and filter-to-waste valve opens for 3 minutes.

11. When filter-to-waste valve closes, filter effluent rate valve opens, and filter is on-line again.

Media are inspected at least once per year. Anthracite is added when needed.

D:4.7 Clearwells

The four finished water storage tanks are independent. All have the same floor elevation and top water elevation. All are fed from the blending chamber, where the effluent streams of the two plants come together and where lime and post-chlorine are added. Tanks No. 1 and No. 2 supply the feed for high lift pumps No. 1 to No. 6. Tanks No. 3 and No. 4 connect to the suction side of high lift pumps No. 7 and No. 8. Should only one group of high lift pumps be used exclusively, then there will be no flow-through in the tanks connected to the other group. However, because all tanks are interconnected via the blending chamber, the total quantity of water stored is always available to any high lift pump.

During normal operation, all tanks are in service. High lift pump duties are alternated manually once daily to ensure a flow through pattern in the tanks. For maintenance, an annual inspection is conducted. At that time, the tank floors are hosed down to remove minor silt or lime sludge accumulations.

D:5 **Chemicals**

D:5.1 **Dosage Determination**

As mentioned earlier, all chemical feeders are paced to a 4-20 mA signal originating from the raw water meter. Consequently, the response of all feeders should be proportional to variations in flow.

Chlorine dosage rates are manually adjusted to maintain a free chlorine residual of 0.5 mg/L in incoming water as well as in system water. During the months of April and May to mid-June, the prechlorination dosage is increased as a matter of policy to obtain a residual of 1.0 mg/L on account of expected taste problems which tend to occur during that season. Chlorine weigh scales are read every 24 hours and the weight loss is recorded.

Alum dosage is occasionally checked by testing with multiple jars, and noting the floc formulation. This procedure is not often done, because the jar test results have proven to be not readily translatable into plant scale results. On a daily basis, one sample is obtained from the rapid mix tank sampling pump. A beaker is filled and placed under the jar tested, gently mixed for 30 minutes and left to settle. Should the floc not settle as well as it should be, the operator will adjust the plant's alum dosage and repeat the above test.

In order to monitor the make-up of the sludge blanket in the Pulsators, four samples are obtained daily from the four sampling pipes in Pulsator No. 1 which are located at different elevations within the blanket. These samples are placed in Imhoff cones and the settling rate in each is noted every five minutes. It has been found that 35-50% solids after 15 minutes (as read on the Imhoff cone graduations) produce good results in the summer, whereas for cold water 25-35% solids readings are desireable.

The output of the alum pumps is checked regularly by directing its pumpage into a calibrated container over a 60 second interval. The alum tank liquid level is read daily and the consumption noted.

Alkalinity of raw water to the Pulsators is adjusted in order to maintain an effective sludge blanket, in the winter only. Lime is fed to the Pulsator influent weir box at low dosages whenever judged necessary. Weights or dosage rates are not recorded.

Coagulant Aid and Filter Aid: Dosage is controlled by operator judgement. The proportion between the two application points is kept constant, at an estimated ratio of 3 to 1. This ratio has been reflected in Tables 2.0 and 2.1. The weight of dry powder used per day is recorded.

Lime dosage for pH control of finished water is manually adjusted to maintain a pH of 7.0 approximately. The daily weight, computed from the number of batches counted, is recorded.

Zinc Polyphosphate dosages to inhibit corrosion in the distribution system are determined by weighing steel coupons inserted in a test rack containing flowing water. The weight loss after 30, 60 and 90 days is converted into a decrease in thickness, which should not be more than 1 mill/yr. (0.025 mm/yr.) The calculations and recommendations are performed by the supplier, Alchem Ltd.

D:5.2 Dosage Application

Alum from the metering pumps is generally diluted with a flow of water of approximately 0.2 L/s to prevent crystallization in the line.

Polyelectrolyte for coagulant and filter aid is also diluted after pumping, mainly to aid in the subsequent dispersion.

D:5.3 **Dosage Calibration**

The output of the metering pumps before 1987 was not regularly checked. It is now done on a monthly basis by measuring the time required to fill vessels with a known volume. The consumption of liquid chemicals is recorded once a day, and so is the weight of chlorine used per day.

D:6 **Sampling and Data Collection**

D:6.1 **In-Plant Monitoring and Testing**

Turbidity	Testing Frequency	Reporting Frequency
- Raw water after chlorination from raw water sampling pump	1 hr	1 hr
- System water from 500 mm diameter main outside the plant	1 hr	1 hr
- Filter effluent of longest running filter	1 hr	1 hr
- Other filters	4 hr	4 hr

The testing instrument is a Hach Ratio turbidimeter Model 18900. The standard instructions for its use are followed, and the instrument is calibrated once a day. A critical factor that is not always realized by inexperienced operators is to allow sufficient time for all air bubbles to escape from the sample. It is believed that some high turbidity values recorded are attributable to this phenomenon. In other cases, high turbidity readings from the system water source are attributed to undissolved lime particles, since filter effluent readings are always kept to less than 0.9 FTU.

pH	Testing Frequency	Reporting Frequency
- Raw water after chlorination from raw water sampling pump	1 hr	1 hr
- Mixed water from rapid mix sampling pump	1 hr	1 hr
- System water from 500 mm diameter main outside the plant	1 hr	1 hr

The testing instrument is Hach DR/3 Spectrophotometer, which is used in accordance with standard instructions. Left hand and right hand scale zero adjustments are made once per week. Occasionally, a Hach model 19200 pH meter is used for comparison and good results are reportedly obtained.

Free Chlorine Residual	Testing Frequency	Reporting Frequency
- Raw water after chlorination from raw water sampling pump	1 hr	1 hr
- System water from 500 mm diameter main outside the plant	1 hr	1 hr

Measurements are made using Hach DPD pillows No. 14070 and a Hach Colorimeter with 0-3.0 colour discs. Readings are made within 1 minute, which is the correct procedure.

Colour	Testing Frequency	Reporting Frequency
- Raw water (after chlorination) from raw water sampling pump	1 hr	1 hr
- System water from 500 mm diameter main outside the plant	1 hr	1 hr

The instrument used is a Fisher Scientific Hellige Aqua tester with a 0-70 colour disc for raw water and a 0-5 disc for finished water. The chlorine added to the raw water may reduce the raw water colour readings.

Temperature	Testing Frequency	Reporting Frequency
- Raw water after chlorination from raw water sampling pump	daily	daily

The thermometer is a 300 mm long laboratory type, scale 0-100°C.

Residual Alum	Testing Frequency	Reporting Frequency
- System water from 500 mm diameter main outside the plant	24 hr	daily

Analysis is done on Hach DR/3 Spectrophotometer.

D:6.2 Out-of-Plant Water Quality Testing

A regular sampling program at monthly intervals is conducted by plant personnel. Samples are collected from:

Sample No.	Location
1	Raw water after chlorination.
2	System water in the plant.
3	Distribution system points: Ramada Inn (west end) McIntyre Arena (east end) City Workshops (south end) City Hall (center town)

These samples are submitted to the Ministry of the Environment Laboratory in Toronto and analyzed for a wide range of constituents as listed in Table No. 4.0, where the results of the analyses of the samples taken at points #1 and #2 are given.

D:6.3 Bacteriological Sampling and Testing

No sampling by plant personnel for bacteriological testing has been in existence until February, 1987, because plant staff believed that the Porcupine Health Unit was doing this, whereas, in fact the Health Unit had terminated the regular program.

Consequently, the only data available for the three year study period were those obtained by inspectors from the Unit taking samples on an irregular basis from nursing homes and private mobile home settlements. By searching all the records, which cover a very large number of sources a limited number of bacteriological sample results for the Timmins distribution system were obtained which have been collected in Table No. 6.1.

Commencing in February, 1987, a regular sampling program by plant personnel has been instituted. Unfortunately raw water sampling

is not included because there is no sampling pump to provide raw water before prechlorination. The present sampling program is therefore confined to the following system water sources:

1.	Plant	
2.	City Hall	- downtown Timmins
3.	Schumacher Arena	- most easterly community
4.	Don Bosco School	- Timmins north
5.	Ruttan's Trailer Park	- Timmins south
6.	Ramada Inn	- Mountjoy - west of Timmins
7.	Random Locations	

The frequency of sampling of locations #1 and #2 is three times a week. For the other points, the frequency is at least once a week, so that a total of 15 to 20 samples per week are submitted. All samples are analysed for Total and Faecal Coliform, and for background bacteria by the Provincial Public Health Laboratory in Timmins.

Test results for the period February to December, 1987, shown on Table 6.0, have all been negative for the two coliform groups, except for 2 instances. Both were immediately resampled and found to be also negative. With respect to background bacteria, 25 samples showed counts varying from 1 to 60 and 6 samples were in the range of 60 to 200. The latter group is equally divided over Timmins north, Timmins south and Schumacher.

D:6.4 Records

Records are made:

Hourly:

* Feed rates of pre- and post-chlorinators, alum, lime, secondary floc and zinc polyphosphate;
* Turbidity of raw and system water;
* pH of raw, mixed and system water;
* Free chlorine residual of raw and system water;
* Colour of raw and system water.

Every 4 Hours: * Turbidity of all working filter effluents.

Every 24 Hours: * Totallizers for raw and system water flow.
* Daily consumptions of chlorine, alum, lime, secondary floc and zinc polyphosphate;
* Residual alum in system water.

Every Month: * Free chlorine residual of four points in the distribution system.

The records are entered on daily log sheets. In addition monthly forms are prepared showing daily flows and consumptions of all chemicals. Furthermore, a yearly report is made to the City Engineer summarizing the plant's performance.

D:7 Process Automation

The basic automated processes are:

* Low lift pumps #1 and #2 speed/output matched to maintain preset water level in pretreatment tanks.
* High lift pumps in various combinations stopping and starting in response to water level in elevated storage tank.
* Output of all chemical feeders proportional to raw water flow.
* Backwash sequence for all filters.
* Desludging of settling tanks by time cycle.

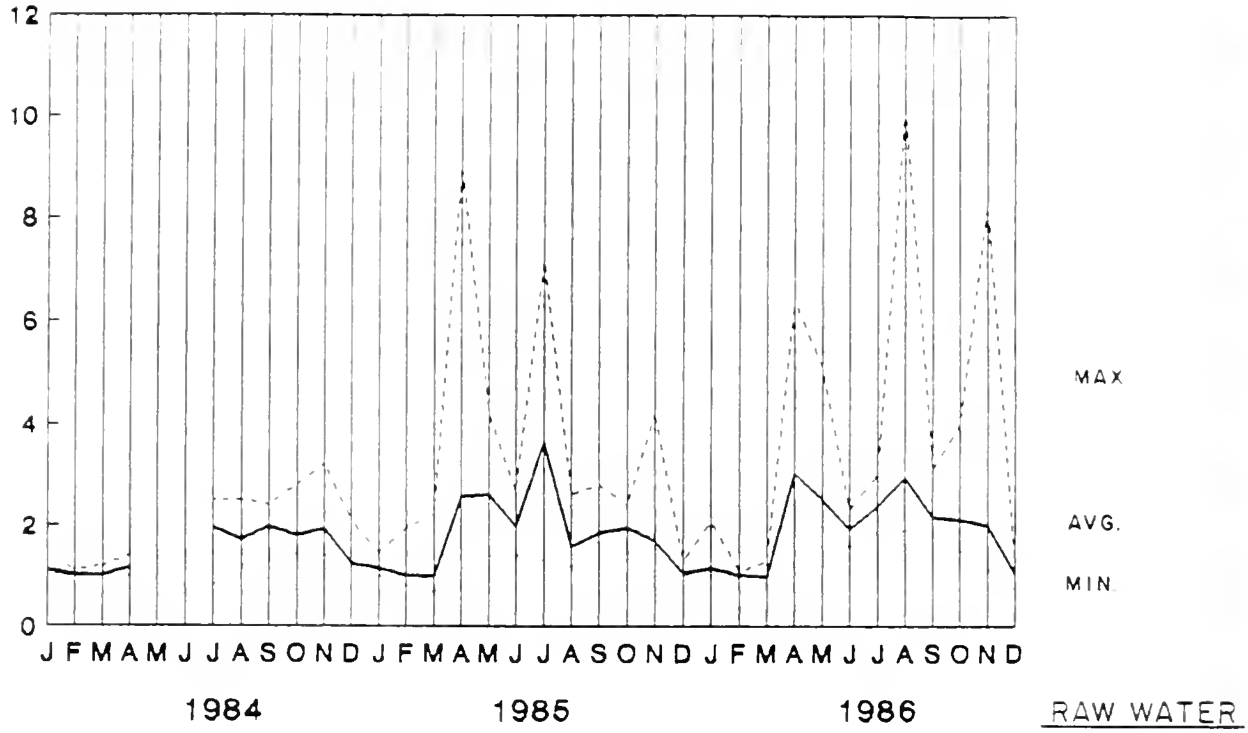
It has been the City's policy to keep automation to the above described level in order to be as independent as possible from the highly specialized service personnel that is needed to maintain sophisticated instrumentation and control loops. Such personnel is not readily available in Timmins, and services provided from Toronto are slow and expensive. The reliability of the plant under the present level of automation is considered to be excellent.

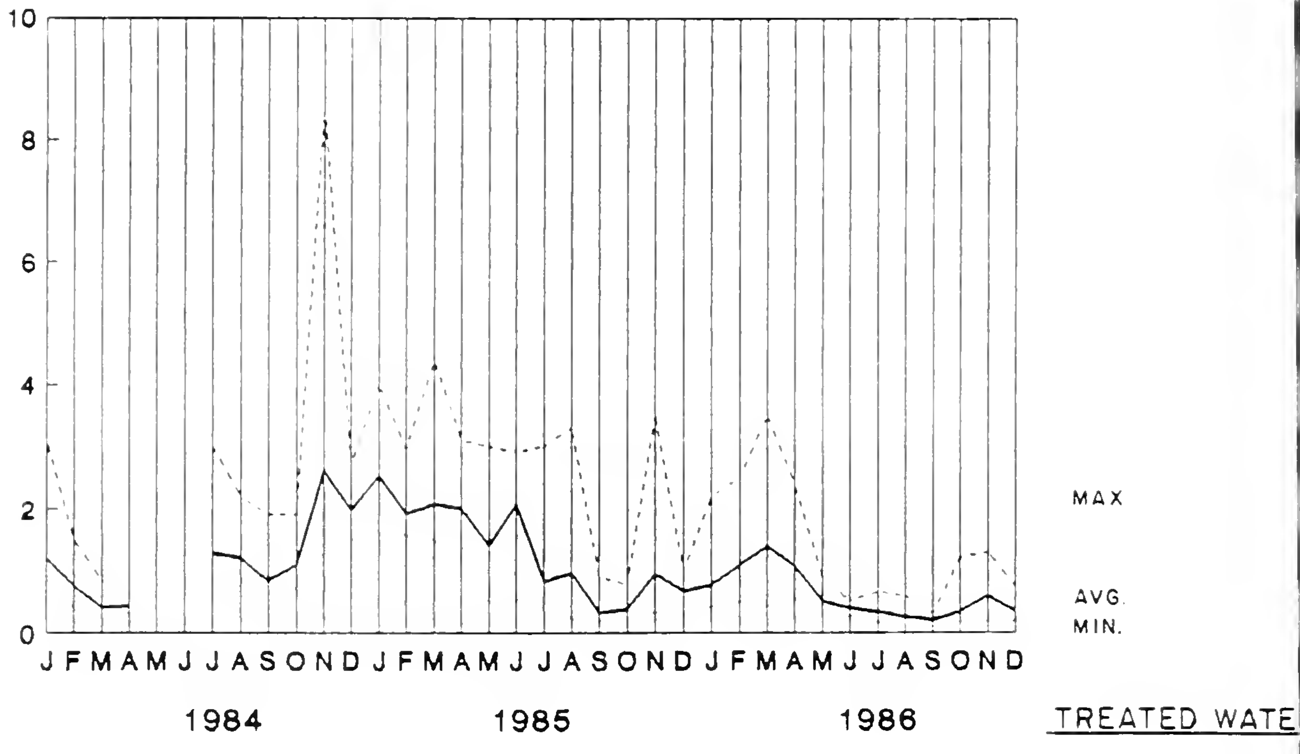
D:8 Daily Operator Duties

During the day shift, two operators are on duty. One of these is fully occupied with maintenance, often assisted by other operators. The duty operator is responsible for the plant operation, that includes the laboratory testing, record keeping, supervising each filter backwash and doing the rounds every hour.

Generator and engine driven pumps are exercised a minimum of one hour per week.

Standing instructions include the starting of certain pumps in case of reports of fire, notifying the Chief Operator of any and all emergencies, and to maintain chlorination at all times.





RAW AND TREATED WATER
MONTHLY TURBIDITY

TIMMINS W
MOE - WPO
PLATE 4

SECTION E - PLANT PERFORMANCE

E:1 Particulate Removal

E:1.1 Validity and Implications of Collected Data

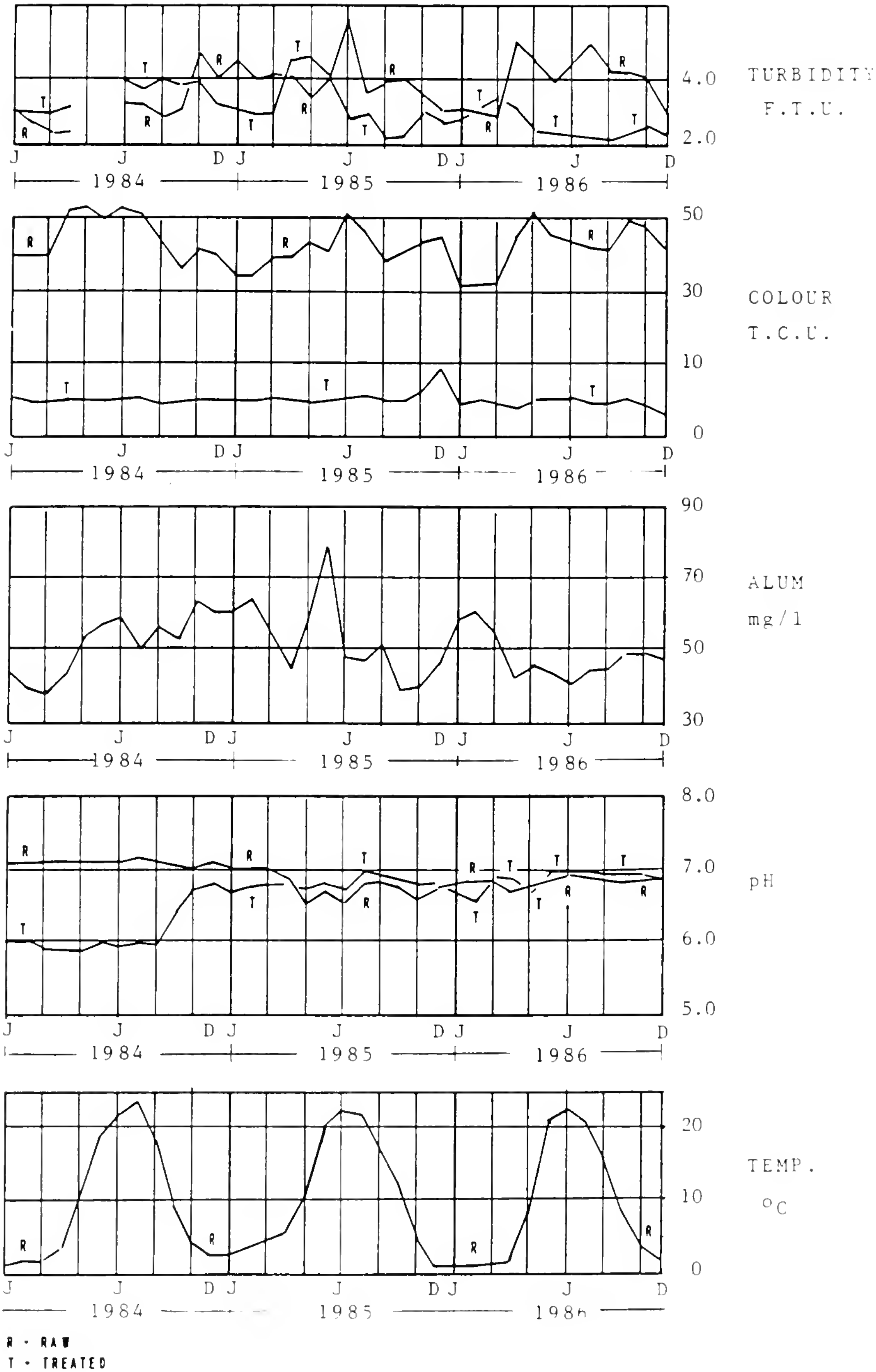
The data collection on particulate removal, as represented by Tables 2.0 and 2.1 is entirely based on records kept and tests made by plant personnel. It has been concluded earlier that these data are considered of adequate accuracy in respect of record keeping methods, flow and weight determinations, as well as lab procedures, and should thereby be considered to be valid. The comparison of plant testing with the Ministry of the Environment test results, shown on page E-2, illustrates that especially turbidity testing results are very consistent. Colour testing at the plant, although reliable, is not accurate because of the type of measuring equipment used and because the raw water has been chlorinated, which could reduce the colour.

The records of turbidity measured in the system water frequently indicate values of 1.0 FTU or higher. In isolated cases, these high values have been attributed to residual air bubbles in the samples. If persisting longer than two hours, plant personnel makes a comparison with filter effluent turbidity which usually shows that the latter values are well below the 1.0 FTU value, which leads to the conclusion that undissolved lime particles in the system water are causing the high readings. However, the higher values have been entered in the logs and records without explanation. It is recommended that in future appropriate entries to this effect be made in the daily logs and on the monthly records. Plate 4 on the opposite page shows that these treated water turbidity anomalies, which are attributed to the above factors, have occurred quite frequently.

In respect of pH, the determinations as described in D:6.1 are considered valid. The consistency of the pH readings, which often show an identical value for many consecutive days, suggests that the Spectrophotometer is perhaps less sensitive than the direct reading pH meter.

TREATED WATER QUALITY - COMPARISON OF IN-PLANT AND M.O.E. TEST RESULTS

DATE	pH		COLOUR		TURBIDITY	
	WTP	MOE	WTP	MOE	WTP	MOE
January 22, 1986	5.80	7.41	3	1.5	0.64	0.29
February 26, 1986	6.90	7.33	3	4.5	0.68	1.11
March 26, 1986	6.80	7.65	7	5.0	2.80	2.40
April 29, 1986	7.00	7.41	5	5.0	0.95	0.48
May 28, 1986	6.90	7.77	5	3.0	0.45	0.30
June 25, 1986	7.00	7.78	5	2.5	0.38	0.20
July 25, 1986	7.05	7.57	5	3.5	0.23	0.19
October 20, 1986	6.95	7.39	5	4.0	0.40	0.24
November 24, 1986	6.90	7.56	5	8.5	0.51	0.60
January 25, 1985	6.55	6.62	5	6.5	2.30	1.70
February 27, 1985	6.90	7.34	5	5.5	2.40	1.42
March 28, 1985	6.90	7.39	5	3.0	1.90	5.00
April 23, 1985	6.70	7.55	5	3.5	1.50	0.73
May 30, 1985	7.00	7.19	5	4.0	0.80	0.45
June 26, 1985	6.90	6.62	5	13.0	1.25	1.80
July 30, 1985	6.90	7.13	5	6.0	0.62	4.80
August 27, 1985	7.10	6.75	5	2.0	0.53	0.63
September 26, 1985	6.90	7.17	5	2.0	0.26	0.34
October 23, 1985	7.00	7.91	5	3.5	0.35	0.71
November 27, 1985	6.75	7.64	7	5.0	0.70	0.45
December 19, 1985	6.90	7.69	12	2.5	0.78	0.39
January 31, 1984	6.00	7.48	5	5.6	1.00	0.42
February 28, 1984	--	7.36	5	2.6	0.54	0.55
March 28, 1984	7.10	6.69	3	2.5	0.28	0.40
April 30, 1984	5.80	6.88	5	7.0	—	1.03
May 29, 1984	6.00	6.69	5	10.5	—	1.47
June 26, 1984	5.90	6.78	5	11.0	—	1.26
July 25, 1984	6.00	7.61	5	9.0	0.92	0.58
August 29, 1984	7.20	7.60	5	5.5	1.20	1.00
September 26, 1984	6.00	7.38	3	3.5	0.65	0.41
October 24, 1984	6.70	7.27	3	7.5	1.10	0.40
November 27, 1984	--	7.43	5	5.0	1.70	0.98



THREE YEAR WATER QUALITY PARAMETERS AND ALUM DOSAGES

TIMMINS WTP
MOE - WPOS
PLATE 5

It should be noted that Tables 2.0 and 2.1 do not show values for residual alum in the treated water until July, 1985. The equipment required to perform these tests was acquired at that time. The initial values for residual alum in the July, August and September months is often relatively high (.15 to .2 mg/L), probably because plant personnel had to learn the skills required and because of complications associated with the start-up of the new plant addition. A residual below 0.1 mg/L is a recommended objective and for the year 1986, this has been achieved on an average monthly basis.

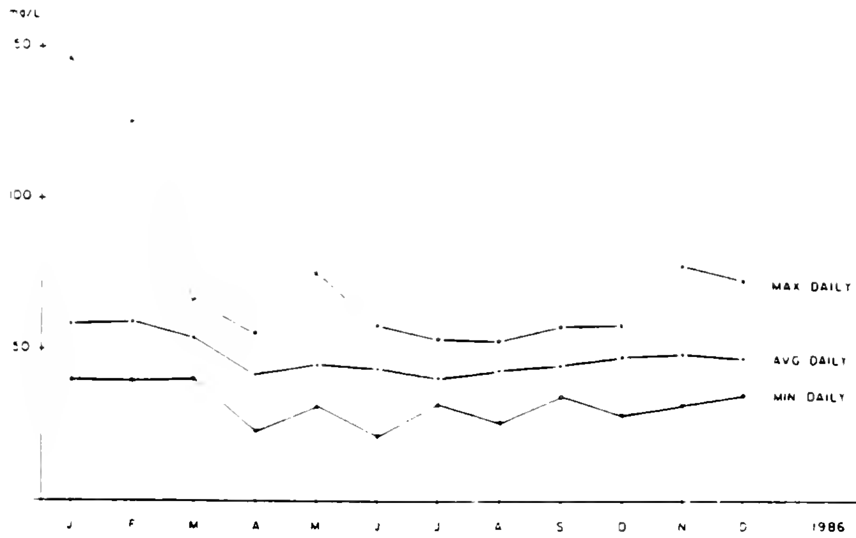
For Free Chlorine Residual data collected by the plant, no outside test results can be used to judge the validity or accuracy. However, tests are done in accordance with standard instructions in every respect. Amperometric titration methods would be more accurate.

The data collected on the weights of chemicals used are considered to be reliable and accurate to within 5% for alum and chlorine, and within 10% for lime.

E:1.2 General Overview

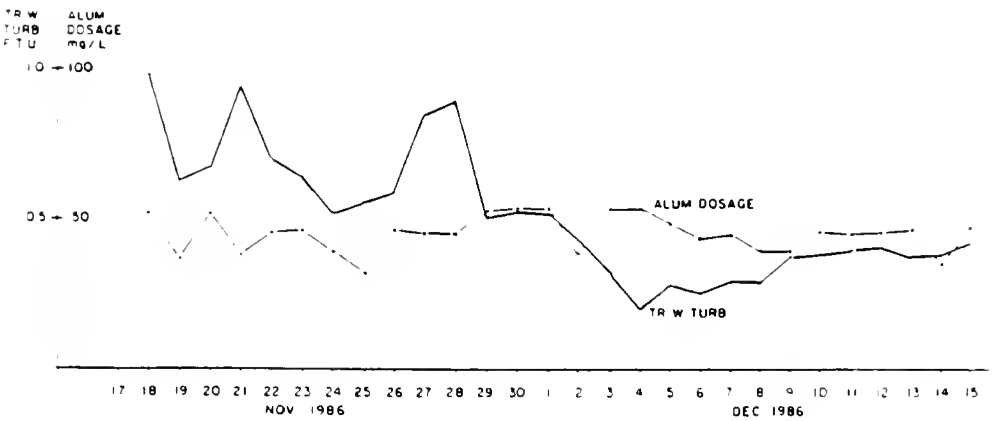
In order to obtain a comprehensive overview of the particulate removal efficiency over the three years of record, graphs have been prepared for the period showing the variations of the turbidity in treated and untreated water, together with the most common water quality parameters and the principal coagulant. The graphs have been reproduced as Plate No. 5 (opposite page) and illustrate that in general terms the performance can be summed up as:

a) Treated water turbidity has been consistently below 1.0 FTU, except during the period of construction (June, 1984 to June, 1985). The construction of the plant addition was a difficult period, requiring many temporary arrangements, disruptions, irregular work schedules, etc. The average value for 1986 was .62 FTU.



ALUM DOSAGE VARIATIONS DURING 1986

A



TREATED WATER TURBIDITY VARIATIONS DURING CONDITIONS OF NEAR CONSTANT RAW WATER CHARACTERISTICS AND COAGULANT DOSAGE

B

TIMMINS WTP
MOE — WPOS
PLATE 6

b) Colour removal is excellent, from 40 to 50 TCU in the raw water to 5 FTU or less in the system water.

A closer examination of the graphs, and of Table 2.0 Particulate Removal Summary, Monthly Record and 2.1 Particulate Removal Profile, Daily Record, reveals a number of inconsistencies.

Example #1: During the first three months of 1986, raw water temperature was low, colour was between 30 and 40 TCU and turbidity in finished water averaged 0.77, 1.10 and 1.40 FTU. During December 1986, raw water characteristics were nearly identical and finished water turbidity averaged .36 FTU. Alum dosages averaged 59, 60 and 56 mg/L for the first three months, and 47 mg/L for the last month. By comparing the two periods, it appears that the higher alum dosages applied early in the year produced a finished water with high turbidity, while the lower dosages later in the year produced far superior results. If undissolved lime particles in the treated water caused the higher turbidity readings early in the year, which is very probable, the reasons should have been noted.

Example #2: Over a few short term periods within the same month the alum dosages varied considerably, despite the fact that raw water characteristics were completely stable. For January 13, 14 and 15, 1984, alum dosage averaged 56.0 mg/L, while for the January 23, 24 and 25 period the dosage was 37.0 mg/L. For February 17, 18, 19, 20 and 21, the dosage averaged 32.8 mg/L. Turbidity removal with the lower dosages was much better.

Example #3: Plate No. 6A shows that during January and February, 1986, maximum alum dosages were 2.5 and 2.1 times average monthly values, indicating significant swings in dosage despite near constant raw water conditions during the first two months. The graph for the remaining period illustrates that these swings decreased rapidly in the latter part of the year. This is probably indicative of the "learning curve" that the plant operators had to go through during the first winter since the start-up of the Degrémont plant.

Example #4: Over a 30-day period in November/December, 1986, raw water characteristics in terms of colour, temperature and turbidity did not change materially. Also, coagulant dosages were relatively constant, yet finished water turbidity values decreased from an "acceptable" level to an excellent level, as shown on Plate No. 6B, opposite page E-4.

Example #5: Over many short periods of three to six days, alum dosages vary considerably, as demonstrated below for the year 1986:

EXAMPLE OF VARIATIONS IN ALUM DOSAGE

Date	mg/L	Date	mg/L	Date	mg/L
Oct. 9	57.57	Nov. 10	51.54	Dec. 1	52.35
10	59.30	11	37.51	2	39.63
11	45.96	12	50.84	3	52.76
		13	79.38		
Oct. 21	47.94	14	63.46	Dec. 13	46.44
22	39.17			14	35.60
23	54.20	Nov. 23	47.26	15	46.46
		24	39.75		
		25	31.94	22	39.24
		26	47.50	23	52.15
				24	46.19

These inconsistencies illustrate that dosage control can be improved without loss of performance. Examples #1 and #2 also suggest that better controls may actually enhance turbidity removal. After all, this removal is one of the prime objectives of water treatment.

E:1.3 Suggestions for Optimization, Using Existing Capital Works

The suggestions made in this sub-section pertain mostly to a rationalization of operating procedures that will result from improved understanding of the various processes, which often are

very complex. In order to obtain a better insight, a rather extensive set of laboratory tests will have to be performed on a continuous basis and many more records will have to be kept. It is also suggested that the City should apply for a special research grant to the Ministry of the Environment to cover the cost of a special research grant for the purposes detailed in subsection F.3.

Other suggestions, which will be elaborated on later, include more detailed logs and records.

The areas in the plant operation that require more rationalization are pretreatment and filtering.

E:1.3.1 Pretreatment

Pretreatment is the most important and most difficult phase of the entire process. The Timmins plant is somewhat more complex than many other plants in this respect, because two entirely different processes are employed simultaneously. To optimize the operation and to establish the minimum dosage rates on a more scientific basis, it will be necessary to systematically evaluate each of the two processes for all the various raw water conditions and other parameters. Specifically, it is recommended that the water chemistry relations be better understood by the following investigations, which should be part of the special study or research program recommended:

1. Adjustment of raw water alkalinity be further studied. Some past experimentation in this direction did not produce positive results, and was discontinued. For instance, it has been found that the sludge blanket in the Degrémont Pulsator was easier to maintain when raw water had been buffered with lime. Many other plants treating Northern waters (low turbidity, high colour) are successful in reducing alum dosages significantly by adjusting alkalinity through addition of lime or sodium-bicarbonate to the raw water. Studies on

the Ottawa River on the other hand found that alum dosage increased with higher alkalinity. These contradictions emphasize the importance of a better understanding of the underlying principles for the different behaviour of the various raw water sources.

2. pH ranges be determined for optimizing alum dosages for colour removal under winter, summer and transition conditions. Raw water alkalinity variations will probably have to be taken into account, although the raw water fortunately fluctuates comparatively little in this respect. Sometimes acids have been used to obtain the low pH required for good alum flocculation. The introduction of acidified alum has been successful in some treatment plants.

3. Use of coagulant aids, and coagulant aid dosage, be reviewed regularly. Variations should be introduced on purpose during periods of constant raw water quality, and the effects on alum dosage, settling characteristics, clarification, etc. be noted and graphed.

4. Variations in frequency and intensity of the Pulsators in the Degrémont Pulsator be tried when all other conditions are constant, and the effects recorded on a systematic basis.

5. The effect of flow variations and corresponding changes in upflow velocities in the Pulsator tanks versus changes in the pulsing intensities should be investigated.

6. The overall depth of, and the density variations within, the sludge blanket in the Pulsators can be varied by the frequency of the sludge blow-off periods and the pulsation frequency. The study should investigate how the blanket depth and density variations affect the coagulant dosage, or ratio between primary and secondary coagulant.

In addition to the above outlined research, or special study program, a number of minor improvements and routine procedures should be considered, as listed below:

7. A regular program of jar testing be initiated. The tests should follow standardized procedures, i.e. introduction of a graduated series of chemical dosages to judge the results of one variation at a time. The tests should produce curves outlining the initial relationship between the many variables. The curves would of course have to be verified by plant scale testing.

   The existing jar testing machine be fitted with a water bath in order to maintain the jars at the raw water temperature existing at that time.

   The samples taken from the rapid mix tank under present procedures and observed for 30 minute to judge the settling characteristics of the floc be also checked for turbidity of the supernatant.

8. Pretreated clarified water quality of each plant be closely monitored for turbidity and suspended solids. A few high intensity spot lights mounted over the Degrémont Pulsators could provide valuable visual clues as to the density and elevation of the sludge blanket. An optical sludge density meter, that can be moved vertically through the blanket should also be considered.

9. The output of the metering pump that supplies supplementary alum to either the Microfloc or to the Degrémont process be checked regularly, by filling and timing a vessel with known volume. This pump is the only means to differentiate the dosages between the two pretreatment systems. Alternatively, a 300 L day tank may be useful.

10. Separate metering pumps be dedicated to supply coagulant aid and filter aid. The present practice of flow splitting is inaccurate and does not permit variations for one purpose or another.

11. Separate records be kept for the Degrémont and the Microfloc plants. These records should be set up to show the output of each plant (based on number of filter hours multiplied by filter rate), the coagulant dosage to each plant, the sludge blanket make-up, the pulsation and desludging cycles, etc.

12. The effect be documented of quality variations in pretreated water on the length of the filter run and the quantity of water produced per run.

13. The performance of all metering pumps be checked from time to time to verify that output is proportional to raw water flow. Because many of the feeders have variable speed motors, it may be sufficient to check the motor revolutions with a tachometer.

E:1.3.2 Filter Performance

Separate records should be kept of the performance of each of the six filters, in order to provide early identification of problems.

The individual filter records should include the quality of the water produced during the filter run, the length of the run, the filter rate, the quantity of water produced between backwashes, the duration of the backwash and the filter-to-waste cycle, the backwash rate and the amount of water used for backwashing. A sample of the backwash water at the end of the backwash cycle should be analyzed for turbidity. Experiments should be conducted to establish if the amount of backwash water can be reduced by an initial wash at low rate, followed by a high rate final rinse.

The dosage of filter aid (polyelectrolyte) and its effect on the efficiency of filtering, as well as on headloss and breakthrough should be investigated. At the present, the total polyelectrolyte feed is split in two streams, one to the rapid mix, the remainder to the clarifier effluent channel. The latter portion, i.e. the filter aid, may not receive sufficient mixing and dispersal in this channel. Continued plant scale testing is required to determine whether the chemical is effective, and at which dosage it works best. Only then can the many different polyelectrolytes which are now available, be properly evaluated. Separate day tanks or installation of meters on each stream are suggested.

The Microfloc filters should be probed on a 300 mm grid once a year to confirm that the support gravel is evenly distributed. The Degrémont filters must be closely observed to spot clogged or broken strainers.

E:1.4 Turbidity Monitoring

Consideration should also be given to the installation of two continuously recording turbidity meters. These meters would eliminate operator bias in obtaining samples and elimination of air bubbles. One meter should monitor, as is now done, the filter effluent of the filter closest to the next backwash. The second meter would be connected to a constant stream of filtered water upstream of the blending chamber and switchable to system water. The latter would prove the existence of undissolved lime particles.

E:1.5 Optimum Removal Strategy

One of the purposes of the Water Plant Optimization Study is to find ways to "Strive for Excellence". To develop a strategy for this purpose, it will be necessary to gain a better insight of the many relationships by instituting the research program proposed in the previous section. Furthermore, there is some evidence that given the existing equipment and operating expertise, turbidities

of 0.5 FTU are obtainable. However, undissolved lime in many cases seems to affect the values. Also there appear to be frequent and considerable swings in dosages as applied that have little justification. It is recommended that dosages be adjusted less freqeuntly and when adjustment is necessary, the reasons be documented.

More careful monitoring of dosages and more detailed records should assist in improving consistency.

E:2 Assessment of Disinfection

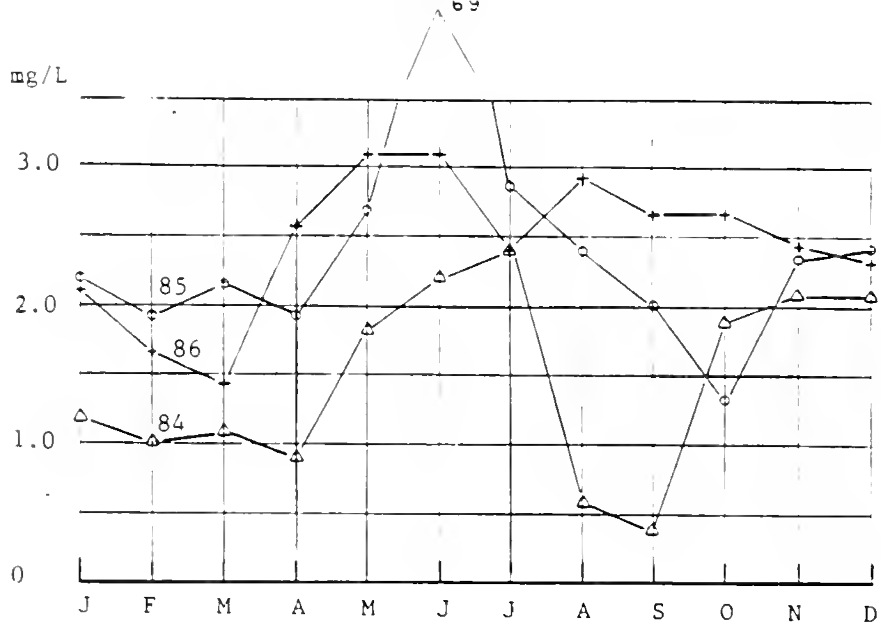
E:2.1 Validity and Implications of Collected Data

As mentioned in the previous comments on particulate removal, the collected data are considered to be sufficiently accurate and entirely valid. The few bacteriological testing results collected for the three year study period, as well as the extensive data analysed for the year 1987 after a regular sampling was introduced, all indicate that the overall efficiency of the bacteriological removal process is excellent.

E:2.2 Observations

Two aspects of chlorination have been more closely examined. The first aspect investigated variations in dosage which are not related to water quality. These are illustrated below.

Variations in flow should not produce changes in chemical dosage. However, many daily variations in pre- and post-chlorination can be found, where the dosages applied are inversely proportional to flow, as shown on the table on the next page. The examples chosen are somewhat biased, in that they represent worst cases. On many other occasions, the dosages remained relatively constant despite significant daily flow variations. The examples tend to illustrate, however, that in 1984, when the raw water flow meter and its signal were in working order, the quantity of chlorine fed

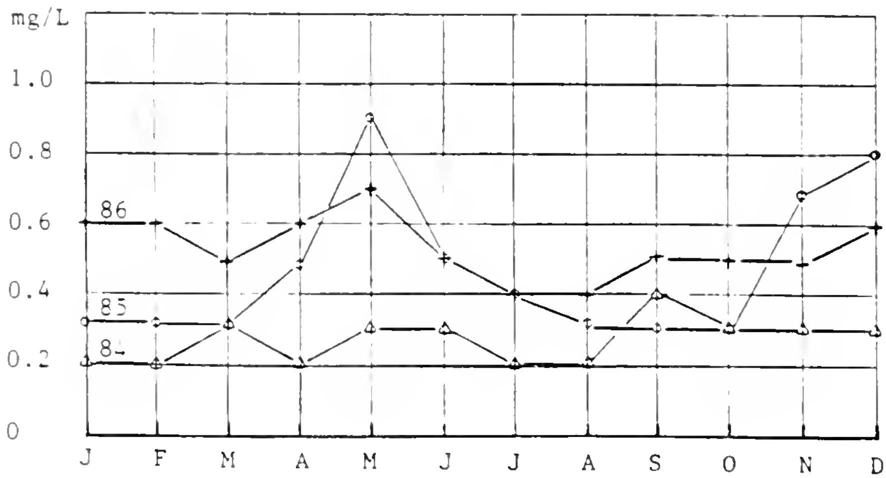


AVERAGE MONTHLY RAW WATER DOSAGES OF CHLORINE

1984 △
1985 o
1986 +

YEARLY AVERAGES

1984	1.5 mg/L
1985	2.6 mg/L
1986	2.5 mg/L



AVERAGE MONTHLY RAW WATER FREE CHLORINE RESIDUAL

1984 △
1985 o
1986 +

YEARLY AVERAGES

1984	0.27 mg/L
1985	0.47 mg/L
1986	0.53 mg/L

TIMMINS WTP
MOE – WPOS
PLATE 7

often was not proportional to flow. During 1986, when no flow meter signal was available, the manual adjustments often lagged behind the flow variations.

EXAMPLES OF CHLORINE DOSAGES NOT PROPORTIONAL TO FLOW

1984		Chlorine Dosage Pre mg/L	Chlorine Dosage Post mg/L	Daily Flow ML/d	1986		Chlorine Dosage Pre mg/L	Chlorine Dosage Post mg/L	Daily Flow ML/d
January	18	1.0	1.1	25.4	April	2	2.2	1.0	23.5
	19	1.3	1.4	21.1		3	1.4	0.7	45.5
	20	1.3	1.3	22.3		4	1.9	0.9	32.7
						5	1.8	0.8	24.9
	30	1.4	1.5	19.9					
	31	1.2	1.3	21.7	May	17	3.9	1.9	25.9
						18	2.3	1.1	34.5
February	9	1.4	1.5	18.2		19	2.0	1.0	39.0
	10	0.9	1.0	23.6		20	3.6	1.7	21.2
	11	1.3	1.4	22.9		21	3.0	1.4	28.0
	12	0.9	0.9	23.9					
	13	1.1	1.1	24.3	June	7	2.5	1.2	27.3
						8	3.5	1.7	18.9
June	15	2.0	2.1	18.8		9	2.5	1.2	31.7
	16	2.4	2.5	14.5		10	2.5	1.2	30.6
	17	2.8	2.9	14.9		11	3.3	1.5	24.3
	18	2.3	2.4	18.8					
	19	2.6	2.7	16.7		18	3.1	1.5	26.5
	20	2.0	2.1	20.8		19	3.6	1.7	22.4
						20	2.6	1.2	28.4

The second aspect that was examined concerns dosage and residuals. Plates No. 7A and 7B show the performance over the last 3 years.

The graphs illustrate:

a) That dosage rates vary considerably during the course of the year, and do not appear to be related to the seasons, except that pre-chlorination dosage is increased annually during April and May as a precaution, because experience has dictated that taste problems occur during that season.

b) That the stated objective of pre-chlorination to achieve 0.5 mg/L free residual is not the most significant criterion, and that other considerations play an important role.

It has been found in Timmins that increased pre-chlorination dosages are very effective in eliminating taste problems. Plant personnel is tasting the water on a routine basis, and dosages are often adjusted as a result. However, tasting is not done in accordance with Standard Methods, and no records are produced.

This absence of documentation makes it impossible to recreate the reasons for the swings in dosage, i.e. caused by high initial chlorine demand from ammonia or organic matter, or to combat taste and odour.

E:2.3 Optimization of Pre-Chlorination

The main purposes of pre-chlorination, in order of importance, are disinfection and control of algae and slime in the pretreatment process. In Timmins, oxidation of taste and odour causing agents also plays an important role. However, the only documented parameter in the plant is free chlorine, measured by the sample delivered by the raw water pump. The above procedure neglects the requirement to minimize the raw water chlorination by-products of the Trihalomethane family. Although the Ministry of the Environment study conducted from 1977 to 1980 (Section E:2.5) concluded that Timmins results were well below the Maximum Acceptable Concentration, there is a suggestion that the average yearly pre-chlorination dosages have increased: 1984 - 1.5 mg/L, 1985 - 2.6 mg/L, 1986 - 2.5 mg/L. Continued vigilance in this matter is considered to be quite important.

In order to optimize the pre-chlorination, given the existing equipment, the following suggestions are put forward:

- The raw and treated water sampling program for THM concentrations be reinstated. (If Timmins wishes to participate in the DWSP, this will be a part of the program.)

- A raw water sampling pump be added to collect raw water before pre-chlorination.

- Raw water chlorine demand testing be instituted.

- Free residual chlorine be determined at downstream points in the process, i.e. filter influent and filter effluent.

- Data be collected on algae formation in the pretreatment tanks.

- Coliform sampling be instituted for raw water before and after pre-chlorination, clarifier effluent and filter effluent.

- Taste and odour determinations in accordance with Standard Methods testing be introduced and the results recorded.

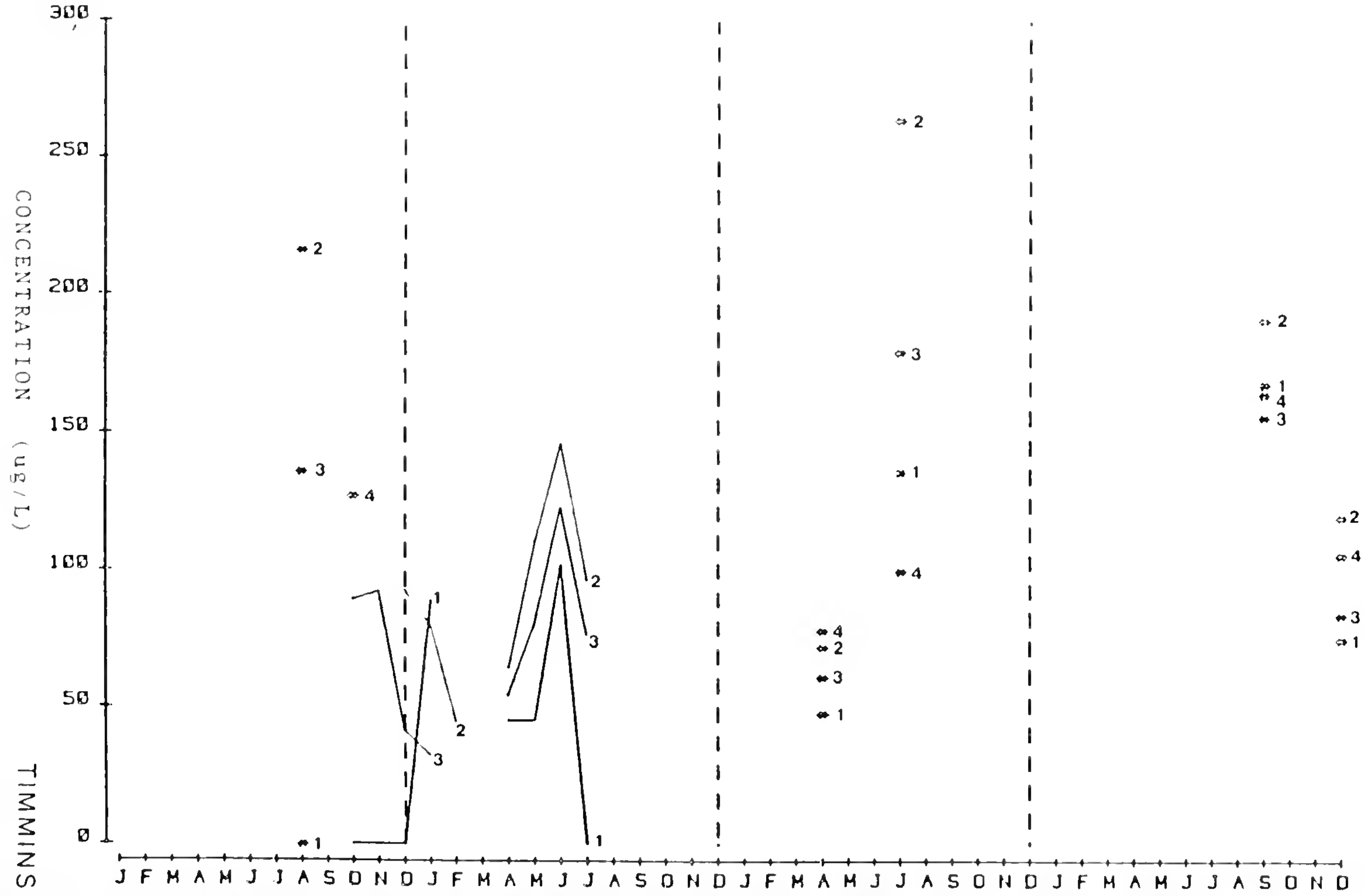
The systematic application of the above measures ought to result in improved knowledge and a possible reduction in pre-chlorination dosages.

E:2.4 Post-Chlorination

Post-chlorination dosages, as illustrated by the examples in Subsection E:2.2, are in a few cases also inversely proportional to flow, which of course should not occur. Therefore, the post-chlorination automatic dosage control must be made more responsive.

It is further recommended that the distribution system water samples collected not only be tested for free chlorine but also for total chlorine. In cases where the free chlorine measured is low, a higher total chlorine residual would indicate that there are still chloramines present that assist in the disinfection. Only in cases when both are very low, should the chlorination dosage be increased.

TOTAL TRIHALOMETHANE
($CHCl_3$ + $CHCl_2Br$ + $CHClBr_2$)



LOCATION
TIMMINS
REGION
NORTHEASTERN

% of TTHM	1977	1978
$CHCl_3$	96.1	96.3
$CHCl_2Br$	3.4	3.3
$CHClBr_2$	0.5	0.4

	1979	1980
$CHCl_3$	97.9	96.8
$CHCl_2Br$	2.1	3.2
$CHClBr_2$	<	<

RAW-UNQUENCHED	1
TREATED-UNQUENCHED	2
TREATED-QUENCHED	3
DIST.-UNQUENCHED	4
< BELOW DETECTION LIMIT	

1981-NOT SAMPLED

TIMMINS WT
MOE - WPOS
PLATE 8

The installation of an automatic residual chlorine analyser and recorder for system water is already being considered. The continuous record will assist in spotting trends. Also, the accuracy of the Amperometric Titration method is far better than the present DPD method.

E:2.5 Trihalomethanes

This aspect of the drinking water in Timmins has been investigated as part of a province-wide study entitled "Trihalomethanes in Ontario Drinking Waters", conducted by the Drinking Water Section of the Ministry of the Environment, in 1985. This study surveyed 138 municipal water systems in Ontario from 1977 to 1982. Trihalomethanes are formed in drinking water as a direct result of chlorination and are of concern because some forms may pose a risk to human health when present at levels above the Maximum Acceptable Concentration (MAC). Canadian Guidelines and Ontario Drinking Water Objectives set the MAC at 350 ug/L for Total Trihalomethanes (TTHM).

Four types of samples were analyzed for volatile organohalides:

1. "raw-unquenched"* - raw water which was not chlorinated;
2. "treated-unquenched" - chlorinated or treated water which contained residual chlorine;
3. "treated-quenched" - chlorinated quenched water containing no residual chlorine after the addition of sodium thiosulphate as the reducing agent;

   * Unquenched samples have no sodium thiosulphate added.

4. "distribution-system-unquenched" - distribution water at the consumer's tap.

The results are reproduced on the opposite page and illustrate that all values found are well below the MAC of 350 ug/L. It is suggested, however, that the City requests an updating of the study.

E:3 Other Aspects of Plant Performance

E:3.1 Corrosion Control

The entire water distribution system in Timmins is made up of cast iron and ductile iron pipe. Most of the system is not cement lined. To limit corrosion that would be caused by the aggressive filtered water, lime is added to the filtered water to adjust the pH. The soft, low alkalinity water from the Mattagami River would probably require a pH of 7.5 to 8.0 to eliminate all corrosion, requiring relatively high lime dosages. However, such high dosages cause many operational problems because lime is difficult to dissolve completely. Incompletely dissolved lime leads to deposits of lime in the clearwells and the piping to the tanks, as well as to customer complaints of taste or milkiness. Also, post-chlorination at high pH is less effective than at lower values.

Phosphates are known to provide good protection for iron because phosphate reacts with iron oxide, in forming a very thin barrier film. Phosphate also acts as a sequestering agent in tying up any dissolved iron. This prevents precipitation of Fe and staining. It has been found that adding zinc or zinc chloride further improves the effectiveness of the polyphosphate.

Pre-blended zinc-phosphate products are available. In Timmins, the ingredients are used separately as a 90% PO_4 polyphosphate powder together with a concentrated zinc chloride solution.

Dosage rates are determined by coupon tests. Coupons are 25 x 75 x 6 mm pieces of mild steel. These are inserted in a test rack through which finished water flows continuously. Coupons are weighed at 30, 60 and 90 day intervals to determine the weight loss. Dosages are adjusted until the coupons lose no more than 0.025 mm per year. For Timmins, where pH adjustment to 7.0 is aimed for, it has been determined that a dosage of 1.0 mg/L is

effective. The dosage calculation is based on the combined weight of the two ingredients.

The distribution system dead ends are flushed twice per year by Public Works maintenance crews, and no reports of "red" water or similar complaints have been received since the polyphosphate protection program has been initiated.

E:3.2 **Waste Volume**

The detailed calculation of waste streams given on page B-3 estimates that the total waste volume is in the order of 10%. This is a high value, and it is recommended that measures be instituted to try and decrease this volume. Not only is there a cost element resulting from the application of wasted pretreatment chemicals and low lift pumping energy but also a minor reduction in the quantity of pretreatment chemicals returned to the river.

The single largest component of the wasted water volume is the desludging of the Pulsators and the Microfloc settling tanks, amounting to 53%. The next highest volume is Neptune filter backwash: 32%. It is proposed that these components be singled out first for a special study to determine methods of reducing these volumes.

E:4 **Treatability Study**

The Drinking Water Section of the Water Resources Branch of the Ministry of the Environment in Toronto conducted a Treatability Study in August, 1987. The Study is dated March, 1988, and is attached as Appendix II. It involved a series of jar tests that:

(a) closely followed plant used chemicals and dosages;
(b) tested various combinations of alternative chemicals.

The Study found good correlation between the water quality parameters from a sample of treated water collected at the plant

(Sample 17-T-T) and from water treated at the laboratory under similar conditions and dosages (Run 17-T-1). The dosages used were 45 mg/L alum and 0.15 mg/L Alchem IU50. The most promising laboratory tests were Runs 17-T-4, using 45 mg/L alum in combination with 4.0 mg/L activated silica and 17-T-5 with 30 mg/L polyaluminum chloride in combination with 2.0 mg/L activated silica.

The last two runs, when compared with plant results, produced lower residual alum concentrations, equal pH, higher chlorides, comparable turbidity and colour, and somewhat lower TTHM levels. The latter values, although within the Ontario Drinking Water Objectives requirements, are still considered comparatively high.

Because the treated water quality obtained by the present plant process meets the ODWO requirements and because the testing program showed potential improvements only in the levels of residual aluminum and TTHM and was conducted at 22°C water temperature, no conclusions can be drawn at this time. Considerable further laboratory efforts are needed to demonstrate that plant scale testing of alternate chemicals should be considered.

SECTION F - POSSIBLE SHORT- AND LONG-TERM IMPROVEMENTS

F:1 General

It is concluded that the plant is basically performing very well and does not require any significant capital works improvements to optimize its performance. Various suggestions have been made in the previous sub-sections to put some of the operations on a more rational, or scientific basis. It should be recognized, however, that this will require a considerable additional effort on the part of the operating staff, and that the savings in chemicals, if any, will be marginal. The main benefits would be a better understanding of the many factors and variables involved, more consistency in the chemical dosages and more consistent excellence of water quality..

F:2 Short Term

The short term improvements suggested are given below, together with a first order cost estimate for each improvement:

1. Installation of automatic, continuously recording analyzers for turbidity and residual chlorine to ease the burden of the increase in testing that is recommended. (Two analyser-recorders - $15,000.)

2. Installation of a sampling pump for filtered water upstream of the blending chamber to monitor finished water before lime addition, in order to judge the effect of undissolved lime particles on system water turbidity. (Two sampling pumps, one for each plant, complete with piping to lab sink - $10,000.)

3. The purchase of two small metering pumps or two separate flow meters to supply filter aid to each plant. This would eliminate the present flow splitting, which is very inaccurate and does not permit the exercise of any control. ($5,000.)

4. A separate day tank to record the quantity of supplementary alum to either of the two pretreatment streams would provide very useful information. ($3,000.)

5. More convenient means of evaluating the nature of the sludge blanket in the Pulsators, i.e. spot lights and sludge density meter to measure concentrations at various elevations. ($8,000.)

6. Verifying the output of all chemical feeders to ensure proportionality with raw water flow.

7. Fitting the jar testing machine with a water bath to duplicate raw water temperature conditions and the introduction of standard jar testing procedures. ($2,000.)

8. Monitoring the turbidity of the two pretreated effluent streams and studying the effect on filter production and backwash volume, requiring two sampling pumps and piping. ($10,000.)

9. Maintaining separate records for the Degrémont and Microfloc plants documenting production and backwashing details.

10. Maintaining a separate record for each filter documenting production and backwashing details.

11. Studying the effect of various dosages of filter aid.

12. Adding a raw water sampling pump to collect raw water before prechlorination by means of a remote submersible pump and discharge pipe routed inside the raw water intake. ($4,000.)

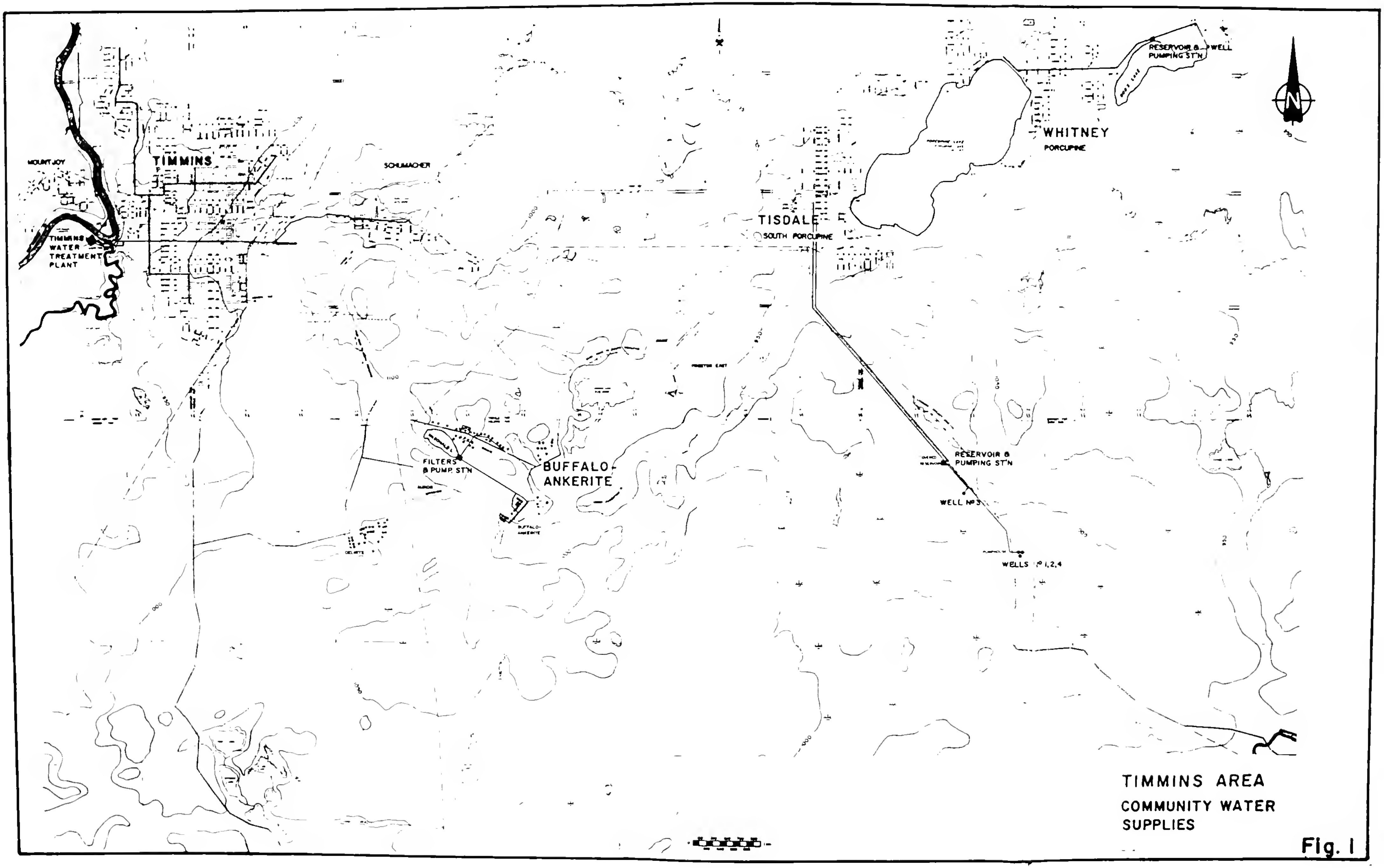
13. Reducing prechlorination dosages by additional testing for raw water chlorine demand and measuring residual chlorine at various downstream points. Standardized taste and odour testing would permit prechlorination adjustment to an "as needed" basis.

14. Analyzing raw and treated water water samples for THM concentrations.

15. Coliform sampling of raw water before and after prechlorination.

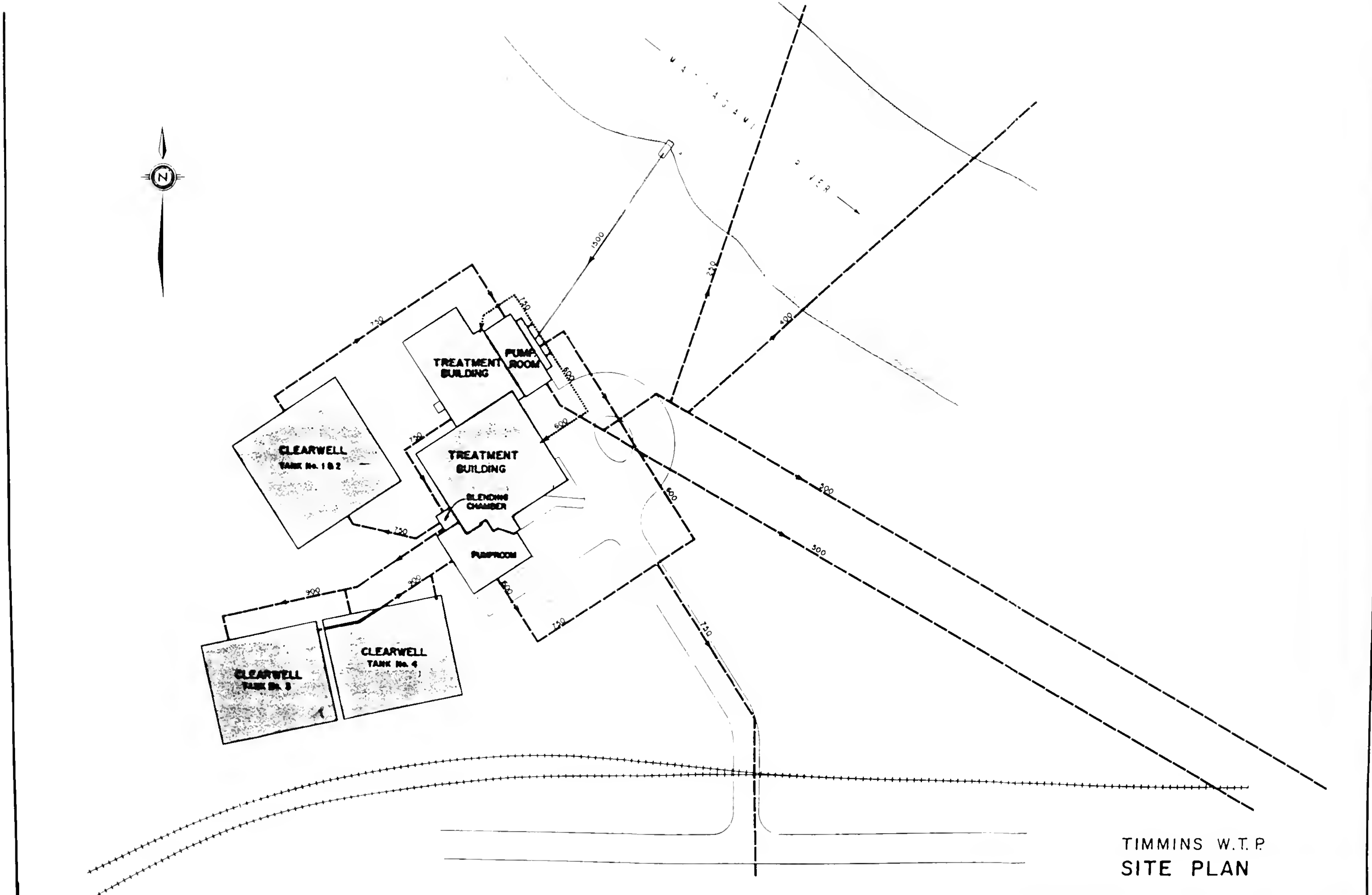
F:3 Long Term

As a longer term improvement , it is proposed that the City should apply to the Ministry of the Environment for a grant to undertake a special research project to investigate the complex relations in the chemistry of the pretreatment. This study should include the services of a water works chemistry technician to do a series of tests during various seasons, under the direction of a chemist or specialized consultant. The aim of the research program would be the production of a "Procedure Manual" for each of the two treatment plants.



TIMMINS AREA
COMMUNITY WATER SUPPLIES

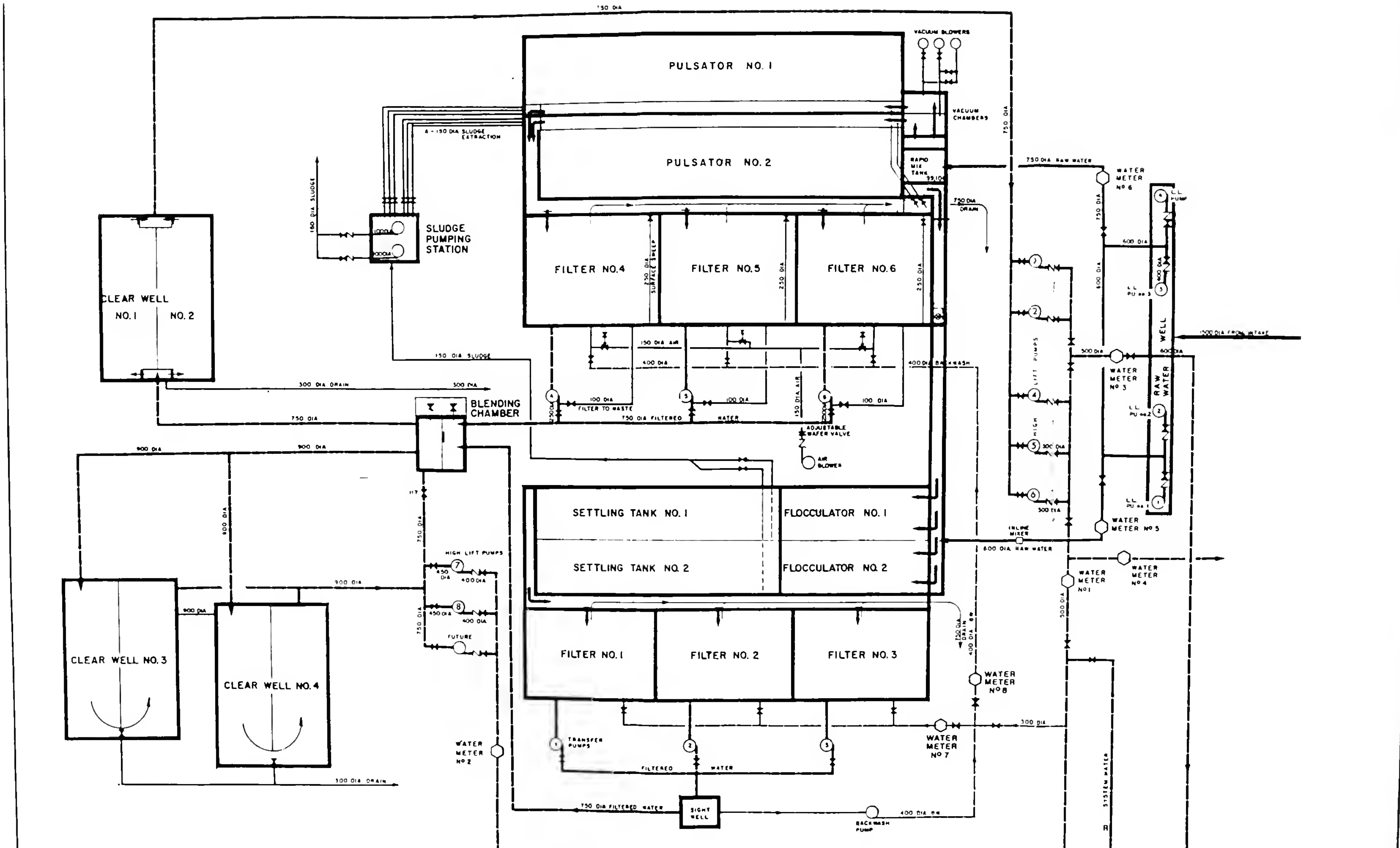
Fig. 1



TIMMINS W.T.P.
SITE PLAN

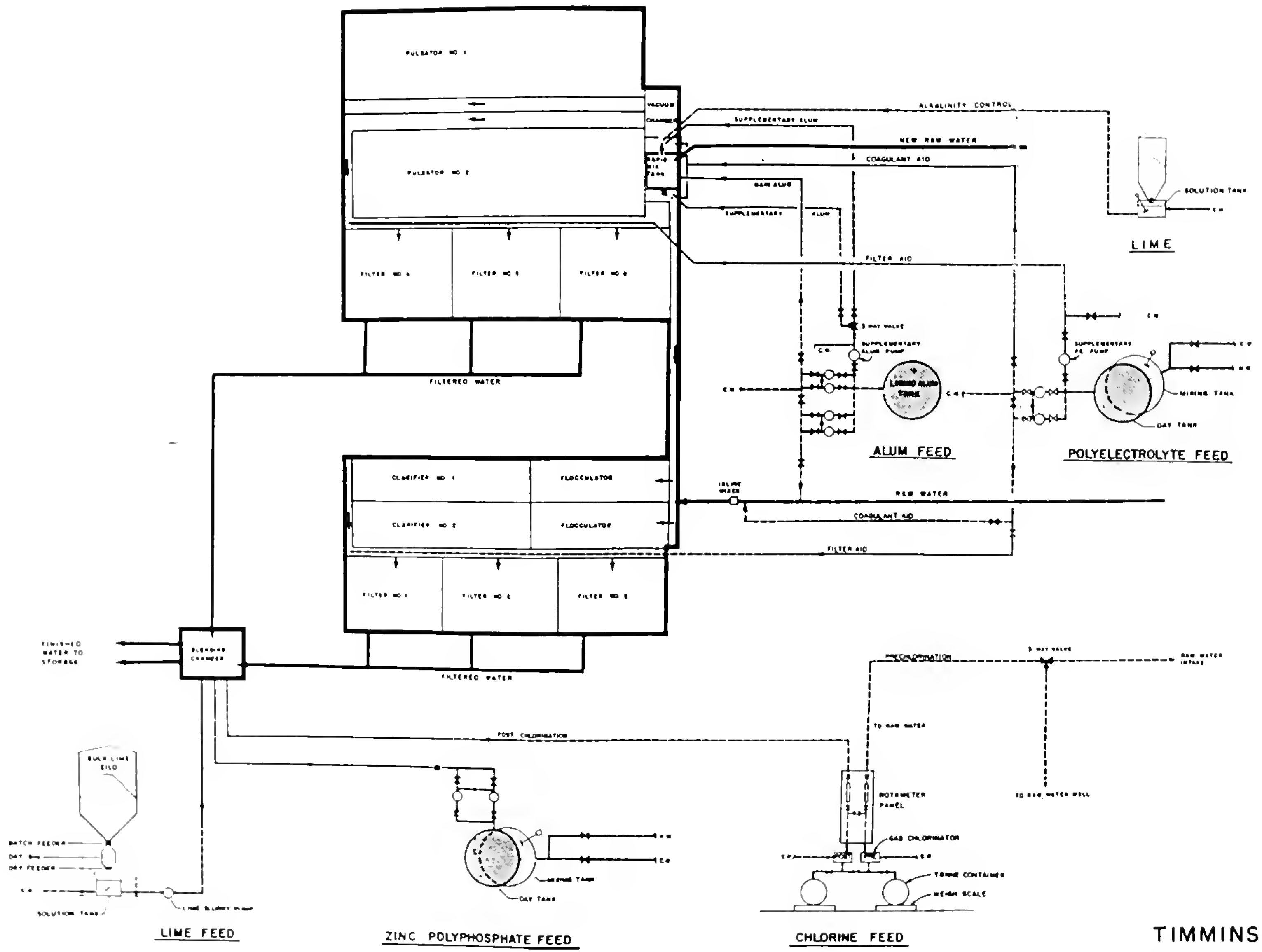
SCALE 1:1000

Fig. 2



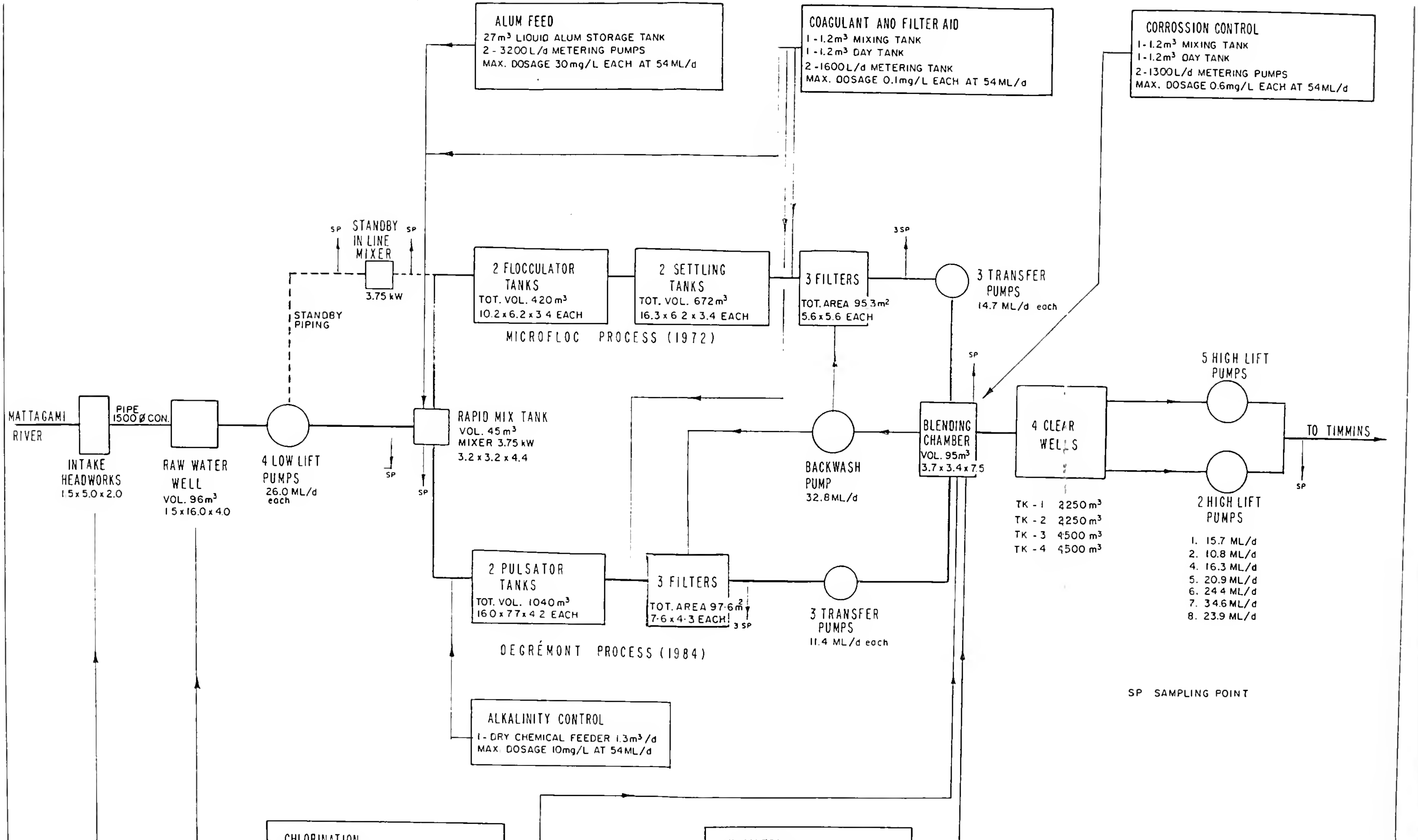
TIMMINS W.T.P.
PROCESS & PIPING DIAGRAM

Fig 3



TIMMINS W.T.P.
CHEMICAL FEED
DIAGRAM

Fig. 4



TIMMINS W.T.P.
BLOCK SCHEMATIC AND SAMPLING POINTS

Fig. 5

TIMMINS WATER TREATMENT PLANT

TABLE 1.0: FLOWS (ML/d)
FOR 1984, 1985 AND 1986

		1984			1985			1986		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	27.9	20.9	23.9	18.7	16.6	17.6	32.8	17.7	21.9
	T	25.4	19.0	21.7	17.0	15.1	16.0	29.8	16.1	19.9
FEB	R	27.4	20.0	25.0	20.1	16.8	17.8	24.1	20.2	22.0
	T	24.9	18.2	22.7	18.3	15.3	16.2	21.9	18.2	20.0
MAR	R	29.9	25.6	26.7	28.6	15.7	20.2	24.3	19.9	22.0
	T	27.2	23.3	24.3	26.0	14.3	18.4	22.1	18.1	20.0
APR	R	28.7	18.7	25.6	26.1	24.1	25.0	50.1	21.5	25.0
	T	26.1	17.0	23.3	23.7	21.9	22.7	45.5	19.5	22.7
MAY	R	24.1	14.2	18.6	29.4	15.8	24.1	42.9	21.5	28.9
	T	21.9	12.9	16.9	26.7	14.4	21.9	39.0	19.5	26.3
JUN	R	27.9	14.7	19.7	22.3	11.1	16.1	34.9	20.8	27.6
	T	25.4	13.4	17.9	20.3	10.1	14.6	31.7	18.9	25.1
JUL	R	25.9	11.8	19.5	37.4	13.4	22.3	45.9	22.8	34.8
	T	23.5	10.7	17.7	34.0	12.2	20.3	41.7	20.7	31.6
AUG	R	26.1	16.2	20.7	39.6	17.4	21.8	37.3	20.5	26.3
	T	23.7	14.7	18.8	36.0	15.8	19.8	33.9	18.6	23.9
SEP	R	18.5	14.6	17.1	41.4	16.6	21.3	26.1	21.8	23.2
	T	16.8	13.3	15.5	37.6	15.1	19.4	23.7	19.8	21.1
OCT	R	20.8	16.4	17.2	35.4	23.4	26.2	26.6	21.2	22.6
	T	18.9	14.9	15.6	32.2	21.3	23.8	24.2	19.3	20.5
NOV	R	19.6	16.8	17.7	29.3	22.4	24.8	24.0	20.9	22.7
	T	17.8	15.3	16.1	26.6	20.4	22.5	21.8	19.0	20.6
DEC	R	19.1	15.1	17.7	37.7	19.8	23.1	24.9	16.4	22.3
	T	17.4	13.7	16.1	34.3	18.0	21.0	22.6	14.9	20.3

R = Raw Water

T = Treated Water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 1.1: PER CAPITA CONSUMPTION (L/D/CAPITA)

YEAR	1984	1985	1986
Population *	36,000	36,000	36,000
Maximum Day	769	1,047	1,264
Minimum Day	297	281	414
Average Day	525	547	631
Ratio MD/AD	1.46	1.91	2.00

* Source: City Planning Department

TIMMINS WATER TREATMENT PLANT

TABLE 1.2: TREATED WATER DAILY FLOWS (ML/d) FOR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	19.0	20.5	24.1	23.9	21.0	20.3	15.5	19.1	15.7	15.5	15.9	15.6
2	19.4	21.4	24.2	25.5	18.2	18.1	23.5	20.0	14.9	15.3	15.9	16.1
3	19.8	19.0	24.0	24.6	21.9	16.9	16.5	21.7	15.4	15.6	16.2	16.3
4	21.1	19.7	24.8	24.7	20.4	22.8	19.1	21.0	16.0	15.7	15.8	16.4
5	19.5	20.1	23.6	23.4	19.8	20.4	17.2	19.1	16.0	15.4	17.1	16.4
6	20.3	22.7	23.8	23.4	19.5	25.4	15.4	20.4	16.2	15.5	16.1	16.3
7	20.3	19.7	23.9	23.9	16.0	21.0	15.3	20.2	15.7	15.1	16.4	16.3
8	21.7	19.3	24.6	23.4	15.9	17.9	15.2	18.7	15.7	15.9	16.1	16.4
9	20.3	18.2	24.3	25.5	15.9	15.2	18.4	18.5	15.5	18.9	17.8	16.4
10	20.2	23.6	24.4	23.4	15.7	13.4	20.2	15.6	16.1	15.0	15.5	16.4
11	22.7	22.9	24.1	24.0	15.3	18.2	22.2	14.7	15.6	15.3	15.3	16.3
12	23.6	23.9	24.8	25.2	15.2	15.6	20.6	16.3	16.1	15.7	16.1	15.9
13	21.2	24.3	24.3	23.3	14.7	16.7	17.9	22.6	16.1	15.4	16.9	16.1
14	22.1	24.4	24.0	23.6	15.8	16.4	17.6	22.5	16.1	15.5	16.2	16.2
15	22.0	23.7	23.8	23.5	16.2	18.2	14.8	20.2	16.1	15.7	15.8	15.8
16	21.8	24.0	24.2	23.8	18.4	14.5	10.7	16.5	15.7	15.5	15.9	16.0
17	23.2	23.8	24.0	23.4	16.3	14.9	---	18.2	14.0	15.3	16.2	16.6
18	25.4	24.1	23.8	23.4	18.1	18.8	---	17.0	16.8	15.1	15.7	16.0
19	21.1	23.6	24.2	23.6	14.8	16.7	---	18.3	13.4	15.0	---	15.8
20	22.3	23.8	23.8	23.2	12.9	20.8	14.8	16.7	13.3	15.0	---	16.0
21	24.8	24.6	27.2	24.1	17.9	20.8	15.7	17.6	15.6	14.9	15.9	15.9
22	22.4	23.0	23.3	22.1	18.1	21.9	16.8	16.9	15.5	15.5	16.0	15.9
23	23.7	24.1	23.6	26.1	17.4	20.0	19.8	17.2	15.4	16.9	15.7	15.7
24	22.0	24.9	24.1	25.2	15.4	14.6	18.2	17.3	15.5	15.3	16.3	16.1
25	22.9	23.6	24.6	24.2	15.2	15.7	17.0	18.6	---	15.3	16.1	15.3
26	22.5	23.4	23.9	20.7	15.2	16.1	17.5	18.5	---	16.2	16.0	13.7
27	23.2	24.0	24.5	17.0	15.3	15.4	18.6	19.1	---	16.0	16.0	16.4
28	22.1	24.0	23.8	21.3	18.5	15.9	20.5	21.8	---	15.3	16.1	16.1
29	21.1	24.0	24.3	19.8	15.3	15.8	16.0	23.7	---	15.3	15.9	16.3
30	19.9	---	24.4	19.7	15.3	18.0	20.3	19.8	---	15.5	16.0	16.0
31	21.7	---	25.4	---	18.9	---	19.4	15.8	---	15.7	---	17.4
MAX.	25.4	24.9	27.2	26.1	21.9	25.4	23.5	23.7	16.8	18.9	17.8	17.4
MIN.	19.0	18.2	23.3	17.0	12.9	13.4	10.7	14.7	13.3	14.9	15.3	13.7
AVG.	21.7	22.7	24.3	23.3	16.9	17.9	17.7	18.8	15.5	15.6	16.1	16.1

R = Raw water
T = Treated Water
Missing data caused by problems with totallizer

Source: Plant records

TABLE 1.2: TREATED WATER DAILY FLOWS (ML/d) FOR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	15.9	15.4	15.7	22.6	22.5	---	19.0	24.1	26.3	22.0	22.1	---
2	16.4	15.7	15.7	22.8	22.5	18.4	---	34.1	16.7	25.2	20.4	34.3
3	16.1	15.3	14.3	22.7	22.5	14.7	21.7	36.0	16.5	26.8	21.8	20.9
4	16.0	16.0	15.3	22.5	23.0	16.1	21.1	21.5	16.5	---	21.4	21.8
5	15.9	16.0	16.1	22.9	22.3	19.1	---	29.5	16.2	25.5	22.2	21.6
6	15.7	16.3	14.7	22.3	23.3	19.1	12.2	16.1	16.0	28.9	21.9	22.3
7	15.9	16.1	16.7	22.4	---	13.9	25.7	16.5	16.3	29.5	21.8	22.0
8	15.6	16.5	16.6	22.6	---	16.0	34.0	16.5	20.6	24.3	22.9	21.2
9	15.9	16.6	14.8	22.6	---	12.6	26.6	27.0	15.1	26.7	21.9	21.4
10	16.2	16.6	15.1	22.8	---	16.0	20.6	15.8	16.4	28.5	22.2	21.9
11	15.9	17.2	15.6	22.2	---	12.5	23.1	16.8	16.4	32.2	22.1	22.9
12	16.6	16.8	15.4	23.3	---	11.9	26.8	16.0	16.9	21.5	21.9	21.7
13	15.1	16.1	15.4	22.1	---	20.3	21.8	16.4	22.0	21.4	22.6	22.1
14	16.1	15.6	---	22.3	---	---	26.3	16.2	37.2	24.3	22.0	21.3
15	16.3	16.1	---	22.8	---	11.5	16.9	16.5	16.4	22.5	21.9	21.0
16	16.2	15.3	---	22.7	---	11.5	16.7	16.3	16.3	21.3	23.2	21.5
17	16.2	15.6	---	22.8	---	11.5	16.7	16.3	17.5	22.4	22.2	22.1
18	16.4	15.9	---	22.6	---	---	16.4	16.3	17.4	22.4	23.3	19.4
19	16.4	15.9	---	22.6	---	14.5	16.3	16.3	21.6	22.0	21.9	19.8
20	16.1	16.0	---	23.5	22.3	---	16.6	16.6	11.6	21.6	22.3	18.0
21	17.0	16.8	---	22.6	22.2	---	16.8	16.4	16.3	23.1	22.2	19.4
22	16.2	15.9	---	22.8	22.7	---	27.2	16.5	37.6	21.9	22.5	19.0
23	15.9	15.9	22.4	23.7	21.7	---	21.4	16.3	17.2	22.6	22.2	19.9
24	15.7	15.8	22.7	22.5	22.6	---	16.5	16.5	21.5	21.3	22.3	19.4
25	15.5	15.5	23.1	22.5	22.2	---	17.3	18.4	22.8	22.3	22.6	19.4
26	15.6	17.4	23.3	22.9	22.3	---	19.9	16.7	22.7	22.8	22.9	19.1
27	15.9	18.3	21.6	21.9	22.2	15.8	17.1	16.2	22.1	22.6	20.9	19.3
28	15.9	17.8	22.3	22.6	23.1	10.1	16.0	22.3	16.6	22.2	22.5	19.3
29	15.7	---	19.4	22.9	26.7	---	16.5	22.7	16.9	22.3	26.6	19.7
30	15.8	---	26.0	22.7	15.7	12.5	25.8	24.2	---	21.4	26.6	19.2
31	15.9	---	22.8	---	14.4	---	17.1	26.3	---	---	25.2	20.2
MAX.	17.0	18.3	26.0	23.7	26.7	20.3	34.0	36.0	37.6	32.2	26.6	34.3
MIN.	15.1	15.3	14.3	21.9	14.4	10.1	12.2	15.8	15.1	21.3	20.4	18.0
AVG.	16.0	16.2	18.4	22.7	21.9	14.6	20.3	19.8	19.4	23.8	22.5	21.0

R = Raw Water
T = Treated Water
Missing data caused by problems with totallizer

Source: Plant records

TABLE 1.2: TREATED WATER DAILY FLOWS (ML/d) FOR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	19.4	19.4	21.8	24.5	25.3	20.2	27.6	28.1	21.7	19.9	21.8	20.5
2	19.3	20.0	18.6	23.5	19.9	24.0	20.7	19.2	20.0	20.4	19.0	20.3
3	19.3	20.2	19.9	45.5	19.6	21.0	23.6	18.6	22.1	21.6	20.1	20.3
4	19.3	19.4	20.1	32.7	20.3	23.2	22.8	21.3	20.2	19.6	21.2	20.2
5	19.7	19.8	21.0	24.9	21.5	25.2	22.7	21.4	20.7	20.7	19.6	22.1
6	19.2	19.9	20.6	21.8	20.5	28.5	31.4	22.5	20.3	20.9	21.6	18.5
7	19.7	21.9	20.8	19.7	19.6	27.3	38.4	31.0	21.0	24.2	20.6	21.3
8	27.1	19.0	20.0	19.8	19.7	18.9	37.7	24.3	20.7	21.3	20.9	20.4
9	22.5	18.2	20.6	19.6	20.0	31.7	34.8	29.6	20.6	21.0	21.2	21.0
10	19.5	20.4	19.9	20.9	19.5	30.6	34.4	25.5	21.2	20.3	20.8	20.4
11	29.8	19.7	22.1	21.2	27.5	24.3	33.3	22.7	20.0	20.4	21.4	20.5
12	19.2	19.1	19.9	20.6	26.6	27.4	31.5	23.0	21.6	19.9	21.1	20.4
13	19.7	19.8	20.0	20.2	26.6	21.0	32.1	22.8	20.4	20.5	20.3	20.2
14	19.8	20.2	20.2	20.4	29.6	25.6	33.7	22.8	20.6	20.3	21.1	22.6
15	17.6	19.9	19.7	21.4	28.7	25.2	39.1	22.6	23.7	19.7	20.4	20.2
16	17.9	20.2	19.6	20.7	27.7	22.6	41.7	27.5	21.4	20.3	20.0	20.1
17	18.0	20.3	19.8	20.0	25.9	23.1	39.4	22.2	20.3	19.5	20.5	20.3
18	17.5	19.9	19.9	19.8	34.5	26.5	35.7	33.9	20.8	20.4	20.5	20.5
19	16.1	20.1	20.5	19.9	39.0	22.4	28.6	31.8	21.0	20.5	21.5	20.3
20	19.4	20.0	20.4	20.7	21.2	28.4	22.9	29.5	21.1	20.8	20.5	20.4
21	18.1	20.1	20.5	19.8	28.0	27.3	30.2	29.3	21.0	19.6	20.4	20.5
22	19.7	20.3	19.3	19.9	24.8	24.1	32.0	23.1	21.1	20.5	20.1	20.5
23	19.3	20.2	18.1	20.4	24.3	27.9	34.4	19.5	21.1	19.8	19.9	20.6
24	19.8	20.4	19.8	19.5	28.5	24.4	28.6	20.5	21.5	19.3	20.2	20.3
25	19.7	20.1	19.5	21.4	26.4	25.9	36.4	23.3	21.1	20.7	21.0	20.0
26	19.9	21.0	21.6	19.5	31.0	23.1	32.5	18.6	22.0	20.0	19.8	20.1
27	19.9	19.8	18.2	19.9	34.1	23.5	34.5	22.8	19.8	20.5	20.3	20.2
28	20.0	20.0	19.5	23.2	31.1	24.7	27.5	20.6	21.2	21.1	20.5	20.3
29	20.8	—	19.8	33.6	36.2	25.6	31.6	20.5	22.5	19.8	20.3	20.1
30	19.6	—	19.7	25.3	32.5	29.0	32.8	20.4	21.6	21.0	20.2	20.0
31	19.4	—	19.7	—	24.1	—	26.2	20.6	—	20.0	—	14.9
MAX.	29.8	21.9	22.1	45.5	39.0	31.7	41.7	33.9	23.7	24.2	21.8	22.6
MIN.	16.1	18.2	18.1	19.5	19.5	18.9	20.7	18.6	19.8	19.3	19.0	14.9
AVG.	19.9	20.0	20.0	22.7	26.3	25.1	31.6	23.9	21.1	20.5	20.6	20.3

R = Raw Water
T = Treated Water
Missing data caused by problems with totallizer

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.0: PARTICULATE REMOVAL SUMMARY - MONTHLY FOR 1984, 1985 AND 1986

			1984			1985			1986		
			MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	Turbidity (FTU)	R	1.40	1.00	1.09	1.45	1.00	1.15	2.10	1.00	1.16
		T	3.10	0.59	1.20	4.00	1.80	2.53	2.20	0.45	0.77
	Colour (TCU)	R	40.	40.	40.	37.	30.	34.9	35.	30.	32.10
		T	10.	5.	5.50	6.	5.	5.00	10.	3.	4.30
	Alum (mg/L)		59.80	35.60	44.70	71.10	37.20	61.20	148.00	39.50	59.00
	Coagulant Aid (mg/L)		0.086	0.067	0.074	0.108	0.088	0.094	0.149	0.080	0.122
	Filter Aid (mg/L)		0.029	0.022	0.025	0.036	0.029	0.031	0.050	0.027	0.041
	Lime (mg/L)	R									
		T	15.7	8.6	11.6	19.2	12.0	16.2			
	Zinc Phosphate (mg/L)	T	1.43	1.07	1.26	1.05	0.93	0.99	0.99	0.53	0.80
	Metal Res Al (mg/L)	T							0.28	0.04	0.10
	pH	R	7.10	7.00	7.10	7.20	7.00	7.03	6.90	6.80	6.82
		T	6.90	5.90	6.01	6.95	6.10	6.68	7.00	5.80	6.68
	Temperature (°C)	R	1.	1.	1.00	4.	2.	2.60	2.	1.	1.20
FEB	Turbidity (FTU)	R	1.10	0.98	1.01	1.95	0.79	0.99	1.10	0.95	1.01
		T	1.50	0.40	0.76	2.95	1.55	1.92	2.50	0.50	1.10
	Colour (TCU)	R	40.	40.	40.	40.	35.	35.4	35.	30.	32.2
		T	5.	5.	5.	6.	5.	5.	10.	3.	5.
	Alum (mg/L)		54.90	29.50	40.40	73.50	50.80	64.40	129.00	40.30	60.10
	Coagulant Aid (mg/L)		0.094	0.069	0.074	0.098	0.083	0.092	0.125	0.081	0.096
	Filter Aid (mg/L)		0.031	0.023	0.025	0.033	0.028	0.031	0.042	0.027	0.032
	Lime (mg/L)	R									
		T	16.2	7.6	11.5	20.8	14.1	17.6			
	Zinc Phosphate (mg/L)	T	1.67	1.10	1.20	1.04	0.87	0.99	0.87	0.72	0.79
	Metal Res Al (mg/L)	T							0.25	0.01	0.08
	pH	R	7.10	7.10	7.10	7.00	7.00	7.00	6.90	6.50	6.87
		T	6.00	5.90	5.99	6.90	6.50	6.75	7.00	5.85	6.58
	Temperature (°C)	R	4.	0.	1.7	4.	2.	3.5	2.	1.	1.
MAR	Turbidity (FTU)	R	1.20	0.89	1.00	2.20	0.66	0.98	1.30	0.85	0.98
		T	0.85	0.25	0.41	4.40	1.50	2.08	3.50	0.45	1.40
	Colour (TCU)	R	40.	40.	40.	47.	35.	39.2	35.	30.	33.
		T	5.	3.	4.9	10.	4.	5.4	8.	3.	4.5
	Alum (mg/L)		48.30	29.10	38.40	78.60	41.20	55.60	68.30	41.20	55.70
	Coagulant Aid (mg/L)		0.073	0.063	0.071	0.101	0.089	0.096	0.094	0.077	0.084
	Filter Aid (mg/L)		0.024	0.021	0.024	0.034	0.030	0.032	0.031	0.026	0.028
	Lime (mg/L)	R									
		T	14.4	7.6	10.4	20.1	8.7	13.4			
	Zinc Phosphate (mg/L)	T				1.11	0.61	0.86	0.88	0.72	0.79
	Metal Res Al (mg/L)	T							0.10	0.02	0.03
	pH	R	7.10	7.10	7.10	7.05	7.00	7.00	6.90	6.85	6.89
		T	6.00	5.90	5.91	7.00	6.60	6.80	7.00	6.75	6.88
	Temperature (°C)	R	3.	1.	1.7	6.	2.	4.5	2.	1.	1.5
APR	Turbidity (FTU)	R	1.40	1.00	1.17	9.00	0.90	2.55	6.40	1.30	3.04
		T	0.59	0.34	0.44	3.10	1.10	2.00	2.40	0.55	1.08
	Colour (TCU)	R	100.	40.	51.7	50.	30.	39.6	55.	30.	44.8
		T	10.	3.	5.1	10.	5.	5.	7.	3.	4.
	Alum (mg/L)		59.60	33.20	43.70	60.00	32.70	45.50	54.20	23.60	42.20
	Coagulant Aid (mg/L)		0.085	0.059	0.073	---	---	---	0.140	0.037	0.088
	Filter Aid (mg/L)		0.028	0.020	0.024	---	---	---	0.047	0.012	0.029
	Lime (mg/L)	R									
		T	14.7	8.6	11.2	20.2	10.0	14.6			
	Zinc Phosphate (mg/L)	T				0.72	0.67	0.70	0.81	0.35	0.70
	Metal Res Al (mg/L)	T							0.08	0.02	0.04
	pH	R	7.10	7.10	7.10	7.00	6.05	6.91	6.90	6.55	6.75
		T	6.00	5.60	5.87	6.95	6.50	6.80	7.10	5.70	6.85
	Temperature (°C)	R	10.	1.5	3.6	8.	2.	5.3	3.5	1.	1.8

R = Raw prechlorinated water
T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

LE 2.0: PARTICULATE REMOVAL SUMMARY - MONTHLY FOR 1984, 1985 AND 1986

			1984			1985			1986		
			MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
.Y	Turbidity (FTU)	R	---	---	---	4.20	1.40	2.61	5.10	1.85	2.50
		T	---	---	---	3.00	0.50	1.40	0.90	0.26	0.51
	Colour (TCU)	R	90.	40.	53.3	50.	40.	43.9	55.	48.	51.9
		T	10.	3.	5.	5.	3.	4.7	5.	3.	4.9
	Alum (mg/L)		69.10	28.90	53.80	93.10	35.80	59.50	75.60	31.80	45.80
	Coagulant Aid (mg/L)		0.114	0.078	0.093	---	---	---	0.145	0.075	0.110
	Filter Aid (mg/L)		0.038	0.026	0.031	---	---	---	0.048	0.025	0.037
	Lime (mg/L)	R									
		T	21.5	10.4	15.1	31.8	7.1	16.0			
	Zinc Phosphate (mg/L)	T	1.23	0.84	0.97	1.10	0.59	0.73	0.81	0.41	0.60
	Metal Res Al (mg/L)	T							0.28	0.02	0.10
	pH	R	7.10	7.10	7.10	6.90	6.05	6.52	7.20	6.60	6.77
		T	6.20	5.60	5.89	7.00	6.40	6.74	7.10	5.30	6.73
	Temperature (°C)	R	12.	2.	10.3	14.	5.	10.2	22.	4.	8.5
N	Turbidity (FTU)	R	---	---	---	2.65	1.40	1.98	2.30	1.60	1.93
		T	---	---	---	2.90	0.56	2.07	0.51	0.28	0.40
	Colour (TCU)	R	100.	40.	50.5	45.	37.	41.4	52.	40.	45.8
		T	5.	5.	5.	5.	3.	4.9	5.	5.	5.
	Alum (mg/L)		70.50	41.50	57.20	133.00	24.00	79.50	59.60	20.90	43.60
	Coagulant Aid (mg/L)		0.113	0.068	0.094	---	---	---	0.144	0.086	0.110
	Filter Aid (mg/L)		0.038	0.023	0.031	---	---	---	0.048	0.029	0.037
	Lime (mg/L)	R									
		T	20.3	11.4	15.2	71.1	12.3	56.7			
	Zinc Phosphate (mg/L)	T	1.19	0.63	0.89				0.84	0.50	0.63
	Metal Res Al (mg/L)	T							0.14	0.03	0.07
	pH	R	7.10	7.10	7.10	6.90	6.40	6.69	6.90	6.70	6.85
		T	6.20	5.80	5.96	7.00	6.30	6.79	7.10	6.80	6.92
	Temperature (°C)	R	24.	12.	18.6	24.	11.	19.9	22.	19.	20.6
L	Turbidity (FTU)	R	2.50	1.70	1.96	7.20	1.30	3.63	3.00	1.90	2.37
		T	3.00	0.65	1.29	3.00	0.43	0.83	0.66	0.18	0.35
	Colour (TCU)	R	60.	40.	52.7	70.	40.	52.1	50.	40.	43.7
		T	10.	5.	5.2	10.	3.	5.1	7.	5.	5.1
	Alum (mg/L)		123.00	41.20	59.60	72.20	20.50	48.20	52.90	31.00	40.40
	Coagulant Aid (mg/L)		0.111	0.067	0.089	---	---	---	0.131	0.065	0.086
	Filter Aid (mg/L)		0.037	0.022	0.030	---	---	---	0.044	0.022	0.029
	Lime (mg/L)	R									
		T	20.3	11.2	16.7				5.5	2.7	3.6
	Zinc Phosphate (mg/L)	T	1.08	0.68	0.95				0.77	0.38	0.50
	Metal Res Al (mg/L)	T	---	---	---	1.10	0.10	0.39	0.12	0.01	0.07
	pH	R	7.10	7.10	7.10	7.00	6.20	6.55	7.10	6.80	6.96
		T	6.20	5.90	5.95	7.10	6.40	6.74	7.10	6.75	6.95
	Temperature (°C)	R	24.	18.5	21.2	24.	20.	22.1	24.	21.	22.
JG	Turbidity (FTU)	R	2.50	1.20	1.71	2.60	1.20	1.57	10.20	1.90	2.95
		T	2.20	0.35	1.20	3.30	0.22	0.97	0.59	0.15	0.27
	Colour (TCU)	R	60.	40.	51.6	50.	40.	46.9	65.	35.	41.8
		T	10.	5.	5.3	17.	5.	5.6	7.	3.	4.6
	Alum (mg/L)		64.50	38.90	50.50	81.50	9.10	47.40	62.80	27.40	44.40
	Coagulant Aid (mg/L)		0.112	0.066	0.088	---	---	---	0.147	0.080	0.114
	Filter Aid (mg/L)		0.037	0.022	0.029	---	---	---	0.049	0.027	0.038
	Lime (mg/L)	R									
		T	25.8	11.4	15.3				28.2	3.3	11.4
	Zinc Phosphate (mg/L)	T	1.08	0.67	0.85				0.85	0.47	0.67
	Metal Res Al (mg/L)	T				0.50	0.06	0.27	0.09	0.01	0.04
	pH	R	7.40	7.10	7.16	7.20	6.40	6.79	7.05	6.75	6.92
		T	6.00	5.90	5.99	7.20	6.70	6.98	7.10	6.85	6.97
	Temperature (°C)	R	24.	21.	23.3	26.	18.	21.8	24.	13.	20.5

R = Raw prechlorinated water
T = Treated water

urce: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.0: PARTICULATE REMOVAL SUMMARY - MONTHLY FOR 1984, 1985 AND 1986

			1984			1985			1986		
			MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
SEP	Turbidity (FTU)	R	2	.26	1.97	2.80	1.20	1.85	3.10	1.80	2.18
		T	1.90	0.48	0.85	0.92	0.19	0.33	0.30	0.12	0.21
	Colour (TCU)	R	50.	35.	44.5	45.	35.	38.3	55.	35.	41.6
		T	5.	3.	4.6	5.	5.	5.	6.	3.	4.5
	Alum (mg/L)		69.90	43.80	57.10	81.20	24.40	51.60	59.60	35.70	45.20
	Coagulant Aid (mg/L)		0.107	0.090	0.098	---	---	---	0.137	0.115	0.129
	Filter Aid (mg/L)		0.036	0.030	0.033	---	---	---	0.046	0.038	0.043
	Lime (mg/L)	R									
		T	24.4	9.8	17.2				19.5	16.3	18.3
	Zinc Phosphate (mg/L)	T	1.13	0.94	1.02	1.37	0.42	0.81	0.80	0.67	0.75
	Metal Res Al (mg/L)	T				0.30	0.02	0.15	0.11	0.02	0.06
	pH	R	7.40	7.00	7.12	7.20	6.60	6.84	7.00	6.70	6.88
		T	6.20	5.80	5.99	7.20	6.65	6.91	7.10	6.45	6.93
	Temperature (°C)	R	24.	8.	18.3	22.	11.	16.8	18.	10.	15.4
OCT	Turbidity (FTU)	R	2.80	1.45	1.80	2.40	1.70	1.96	4.00	1.55	2.13
		T	1.90	0.75	1.09	0.78	0.19	0.39	1.20	0.18	0.35
	Colour (TCU)	R	45.	30.	36.6	45.	35.	41.5	60.	35.	48.9
		T	5.	3.	4.8	5.	5.	5.	10.	0.	5.1
	Alum (mg/L)		75.10	53.80	65.10	77.30	19.90	39.40	59.30	39.20	48.90
	Coagulant Aid (mg/L)		0.112	0.084	0.103	---	---	---	0.141	0.113	0.134
	Filter Aid (mg/L)		0.037	0.028	0.034	---	---	---	0.047	0.038	0.045
	Lime (mg/L)	R									
		T	21.1	13.2	16.7				20.0	15.9	18.9
	Zinc Phosphate (mg/L)	T	1.07	0.84	1.02	0.75	0.70	0.72	0.82	0.66	0.78
	Metal Res Al (mg/L)	T				0.32	0.02	0.09	0.50	0.00	0.09
	pH	R	7.10	7.00	7.08	7.30	6.30	6.74	6.90	5.90	6.84
		T	6.90	5.90	6.43	7.20	6.50	6.82	7.20	6.55	6.92
	Temperature (°C)	R	14.	2.	9.2	24.	8.	12.	16.	4.3	13.6
NOV	Turbidity (FTU)	R	3.20	1.40	1.92	4.20	1.10	1.69	8.30	1.15	2.01
		T	8.60	1.30	2.61	3.50	0.35	0.95	1.30	0.19	0.60
	Colour (TCU)	R	45.	35.	41.5	50.	40.	43.5	70.	40.	48.8
		T	10.	3.	5.	15.	5.	6.4	5.	0.	4.4
	Alum (mg/L)		78.70	51.60	63.90	60.60	30.00	40.50	79.40	31.90	49.20
	Coagulant Aid (mg/L)		0.113	0.090	0.100	---	---	---	0.143	0.113	0.133
	Filter Aid (mg/L)		0.038	0.030	0.033	---	---	---	0.048	0.038	0.044
	Lime (mg/L)	R									
		T	21.7	10.0	17.5				20.3	17.7	18.7
	Zinc Phosphate (mg/L)	T	1.02	0.93	0.99	0.78	0.60	0.71	0.83	0.73	0.77
	Metal Res Al (mg/L)	T	---	---	---	1.50	0.02	0.32	0.10	0.02	0.06
	pH	R	7.10	6.80	7.04	7.00	5.20	6.60	7.00	6.80	6.89
		T	7.10	6.20	6.72	7.80	6.40	6.82	7.00	6.75	6.91
	Temperature (°C)	R	7.	2.	4.1	9.	0.3	4.9	7.	2.	3.5
DEC	Turbidity (FTU)	R	2.10	0.96	1.25	1.30	1.00	1.05	1.20	0.90	1.05
		T	2.70	1.50	1.98	0.98	0.32	0.68	0.75	0.20	0.36
	Colour (TCU)	R	40.	35.	39.7	50.	40.	44.8	45.	35.	41.5
		T	5.	4.	5.	15.	5.	9.6	5.	3.	3.1
	Alum (mg/L)		73.70	50.70	60.70	62.50	16.00	46.70	72.00	35.60	47.20
	Coagulant Aid (mg/L)		0.104	0.086	0.095	---	---	---	0.180	0.121	0.134
	Filter Aid (mg/L)		0.035	0.029	0.032	---	---	---	0.060	0.040	0.045
	Lime (mg/L)	R									
		T	18.9	12.5	15.7				25.9	17.1	19.1
	Zinc Phosphate (mg/L)	T	1.16	0.92	0.99	0.88	0.24	0.71	1.07	0.70	0.78
	Metal Res Al (mg/L)	T				0.54	0.02	0.14	0.02	0.02	0.02
	pH	R	7.10	7.00	7.09	6.80	6.60	6.74	7.00	6.90	6.90
		T	7.00	6.40	6.80	7.00	6.60	6.81	7.00	6.80	6.88
	Temperature (°C)	R	4.	1.	2.6	2.	0.	1.	2.	1.	1.7

R = Raw prechlorinated water
T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JANUARY 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.0	0.69	40	5	7.1	6.0	1	44.32	0.086	0.029	
2	1.0	0.59	40	5	7.1	5.9	1	43.49	0.086	0.029	
3	1.0	0.82	40	5	7.1	5.9	1	42.69	0.086	0.029	
4	1.0	1.0	40	5	7.1	5.9	1	46.67	0.078	0.026	
5	1.2	2.3	40	10	7.1	6.9	1	36.03	0.084	0.028	
6	1.2	3.1	40	10	7.1	5.9	1	48.55	0.076	0.025	
7	1.2	0.78	40	5	7.1	5.9	1	41.57	0.084	0.028	
8	1.4	0.65	40	5	7.1	6.0	1	45.49	0.074	0.024	
9	1.1	0.72	40	5	7.1	6.0	1	41.49	0.078	0.026	
10	1.1	0.68	40	5	7.1	6.0	1	41.86	0.081	0.027	
11	1.05	0.93	40	5	7.1	6.0	1	37.21	0.074	0.024	
12	1.05	2.2	40	5	7.1	6.0	1	53.72	0.068	0.023	
13	1.1	1.1	40	5	7.0	6.0	1	59.79	0.078	0.026	
14	1.05	2.5	40	5	7.1	6.0	1	50.82	0.074	0.024	
15	1.1	1.8	40	5	7.1	6.0	1	57.44	0.074	0.024	
16	1.1	2.0	40	5	7.1	6.0	1	45.24	0.078	0.026	
17	1.2	0.98	40	5	7.1	6.0	1	48.60	0.078	0.026	
18	1.0	2.5	40	10	7.1	6.0	1	44.27	0.067	0.022	
19	1.1	1.2	40	5	7.1	6.0	1	46.61	0.086	0.029	
20	1.1	0.81	40	5	7.1	6.0	1	44.15	0.081	0.027	
21	1.1	0.92	40	5	7.1	6.0	1	39.70	0.074	0.024	
22	1.0	1.1	40	5	7.1	6.0	1	43.96	0.078	0.026	
23	1.0	0.94	40	5	7.1	6.0	1	35.61	0.074	0.024	
24	1.1	0.72	40	5	7.1	6.0	1	38.45	0.076	0.025	
25	1.15	0.75	40	5	7.1	6.0	1	36.92	0.071	0.024	
26	1.15	0.71	40	5	7.1	6.0	1	50.13	0.078	0.026	
27	1.1	0.82	40	5	7.1	6.0	1	48.46	0.074	0.025	
28	1.0	1.10	40	5	7.1	6.0	1	38.22	0.074	0.025	
29	1.0	0.71	40	5	7.1	6.0	1	46.73	0.069	0.023	
30	1.0	1.0	40	5	7.1	6.0	1	49.51	0.071	0.024	
31	1.05	1.0	40	5	7.1	6.0	1	38.97	0.074	0.025	
MAX.	1.4	3.1	40	10	7.1	6.9	1	59.79	0.086	0.029	
MIN.	1.0	0.59	40	5	7.0	5.9	1	35.61	0.067	0.022	
AVG.	1.09	1.20	40	5.48	7.1	6.01	1	44.73	0.074	0.025	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - FEBRUARY 1984

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.05	0.69	40	5	7.1	6.0	1	54.94	0.083	0.028	
2	1.0	0.65	40	5	7.1	6.0	1	46.88	0.081	0.027	
3	1.0	0.73	40	5	7.1	6.0	2	51.76	0.090	0.030	
4	1.0	0.71	40	5	7.1	6.0	1	50.06	0.087	0.029	
5	1.0	0.59	40	5	7.1	6.0	1	49.05	0.085	0.028	
6	1.0	0.82	40	5	7.1	6.0	1	49.52	0.075	0.025	
7	1.0	0.96	40	5	7.1	5.9	1	42.90	0.087	0.029	
8	1.0	1.1	40	5	7.1	6.0	1	43.64	0.088	0.029	
9	1.0	1.5	40	5	7.1	5.9	1	46.37	0.094	0.031	
10	1.0	0.66	40	5	7.1	6.0	1	35.80	0.072	0.024	
11	1.0	0.75	40	5	7.1	6.0	1	42.99	0.074	0.025	
12	1.0	0.93	40	5	7.1	6.0	2	41.14	0.071	0.024	
13	1.0	0.94	40	5	7.1	6.0	0	40.58	0.070	0.023	
14	1.0	0.78	40	5	7.1	6.0	0	34.53	0.070	0.023	
15	1.1	1.0	40	5	7.1	6.0	0	38.59	0.072	0.024	
16	1.05	0.75	40	5	7.1	6.0	2	38.03	0.071	0.024	
17	1.0	0.68	40	5	7.1	6.0	2	29.53	0.072	0.024	
18	1.0	0.76	40	5	7.1	6.0	2	34.97	0.071	0.024	
19	1.0	0.79	40	5	7.1	6.0	2	35.71	0.072	0.024	
20	1.0	0.82	40	5	7.1	6.0	2	29.53	0.072	0.024	
21	1.0	0.73	40	5	7.1	6.0	2	34.35	0.069	0.023	
22	1.0	0.59	40	5	7.1	6.0	2	42.74	0.074	0.025	
23	1.0	0.44	40	5	7.1	6.0	2	43.73	0.071	0.024	
24	1.0	0.40	40	5	7.1	6.0	2	42.43	0.069	0.023	
25	1.0	0.44	40	5	7.1	6.0	4	41.67	0.072	0.024	
26	1.0	0.53	40	5	—	—	3	36.02	0.073	0.024	
27	1.0	0.92	40	5	—	—	3	35.19	0.071	0.024	
28	1.0	0.54	40	5	—	—	3	35.18	0.071	0.024	
29	0.98	0.87	40	5	—	—	3	35.14	0.075	0.025	
30											
31											
MAX.	1.10	1.50	40	5	7.10	6.00	4	54.94	0.094	0.031	
MIN.	0.98	0.40	40	5	7.10	5.90	0	29.53	0.069	0.023	
AVG.	1.01	0.76	40	5	7.10	59.9	1.66	40.40	0.074	0.025	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MARCH 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.0	0.65	40	5	7.1	5.9	2	40.91	0.071	0.024	
2	1.0	0.78	40	5	7.1	5.9	2	34.92	0.071	0.024	
3	0.98	0.65	40	5	7.1	5.9	2	35.17	0.071	0.024	
4	1.0	0.58	40	5	7.1	5.9	1	34.00	0.069	0.023	
5	1.0	0.45	40	5	7.1	5.9	1	35.70	0.072	0.024	
6	1.0	0.25	40	5	7.1	5.9	1	35.43	0.072	0.024	
7	0.89	0.37	40	5	7.1	5.9	1	41.27	0.071	0.024	
8	1.0	0.42	40	5	7.1	5.9	1	34.35	0.069	0.023	
9	1.0	0.32	40	5	7.1	5.9	1	46.37	0.070	0.023	
10	1.0	0.31	40	5	7.1	5.9	1	42.57	0.073	0.024	
11	1.0	0.38	40	5	7.1	5.9	1	40.80	0.071	0.024	
12	0.95	0.38	40	5	7.1	5.9	1	34.08	0.069	0.023	
13	0.95	0.48	40	5	7.1	5.9	1	34.78	0.070	0.023	
14	1.0	0.51	40	5	7.1	5.9	1	35.17	0.071	0.024	
15	1.0	0.40	40	5	7.1	5.9	2	35.46	0.072	0.024	
16	1.0	0.40	40	5	7.1	5.9	1	29.10	0.071	0.024	
17	1.0	0.85	40	5	7.1	5.9	2	41.12	0.071	0.024	
18	1.0	0.32	40	5	7.1	5.9	2	41.47	0.072	0.024	
19	1.0	0.31	40	5	7.1	5.9	2	29.12	0.071	0.024	
20	1.0	0.29	40	5	7.1	5.9	2	41.34	0.072	0.024	
21	1.0	0.35	40	5	7.1	5.9	2	46.51	0.063	0.021	
22	1.0	0.35	40	5	7.1	5.9	2	48.33	0.073	0.024	
23	1.0	0.29	40	5	7.1	5.9	2	35.72	0.072	0.024	
24	1.0	0.30	40	5	7.1	5.9	2	40.85	0.071	0.024	
25	0.98	0.29	40	5	7.1	5.9	2	40.06	0.069	0.023	
26	1.0	0.32	40	5	7.1	5.9	2	35.37	0.071	0.024	
27	1.0	0.27	40	5	7.1	5.9	2	40.18	0.070	0.023	
28	1.0	0.28	40	3	7.1	5.9	2	47.38	0.072	0.024	
29	1.1	0.33	40	5	7.1	6.0	3	40.56	0.071	0.024	
30	1.0	0.34	40	5	7.1	6.0	2	34.54	0.070	0.023	
31	1.2	0.36	40	5	7.1	6.0	2	38.56	0.068	0.023	
MAX.	1.20	0.85	40	5	7.1	6.0	3	48.33	0.073	0.024	
MIN.	0.89	0.25	40	3	7.1	5.9	1	29.10	0.063	0.021	
AVG.	1.00	0.41	40	4.94	7.1	5.91	1.65	38.42	0.071	0.024	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - APRIL 1984

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.25	0.34	40	5	7.1	5.9	4	47.12	0.065	0.025	
2	1.3	0.36	40	5	7.1	5.9	1.5	44.09	0.065	0.022	
3	1.25	0.59	40	5	7.1	5.9	3	45.78	0.074	0.025	
4	1.1	0.55	40	5	7.1	5.9	2	45.52	0.069	0.023	
5	1.1	0.45	40	5	7.1	6.0	2	42.07	0.076	0.025	
6	1.1	0.40	40	5	7.1	6.0	3	42.07	0.073	0.024	
7	1.25	0.37	40	5	7.1	6.0	3	41.27	0.073	0.024	
8	1.0	0.39	40	5	7.1	5.9	2	42.07	0.076	0.025	
9	1.1	0.42	40	5	7.1	5.9	2	33.16	0.067	0.022	
10	1.0	0.46	40	5	7.1	5.9	2	36.06	0.073	0.024	
11	1.1	0.43	40	5	7.1	5.9	2	41.12	0.071	0.024	
12	1.2	0.44	40	5	7.1	5.9	3	39.16	0.068	0.023	
13	1.4	0.49	40	5	7.1	5.9	3	42.20	0.073	0.024	
14	--	--	40	5	7.1	5.9	3	41.70	0.072	0.024	
15	--	--	40	5	7.1	5.9	3	47.95	0.073	0.024	
16	--	--	40	5	7.1	5.9	3	35.52	0.072	0.024	
17	--	--	50	3	7.1	5.9	3	36.11	0.073	0.024	
18	--	--	55	5	7.1	5.9	4	42.12	0.071	0.024	
19	--	--	65	5	7.1	5.8	4	59.60	0.059	0.020	
20	--	--	70	5	7.1	5.9	4	42.34	0.060	0.020	
21	--	--	60	5	7.1	5.9	4	40.90	0.071	0.024	
22	--	--	70	10	7.1	5.9	4	38.13	0.085	0.028	
23	--	--	70	5	7.1	5.9	4	43.18	0.072	0.024	
24	--	--	70	5	7.1	5.9	4	44.61	0.068	0.023	
25	--	--	80	10	7.1	5.9	4	40.69	0.070	0.023	
26	--	--	60	3	7.1	5.7	4	54.33	0.080	0.027	
27	--	--	60	3	7.1	5.6	3	66.33	0.079	0.026	
28	--	--	50	5	7.1	5.6	3.5	46.30	0.075	0.025	
29	--	--	50	5	7.1	5.8	10	49.69	0.076	0.025	
30	--	--	100	5	7.1	5.8	10	50.04	0.083	0.028	
31											
MAX.	1.40	0.59	100	10	7.1	6.0	10	59.60	0.085	0.028	
MIN.	1.00	0.34	40	3	7.1	5.6	1.5	33.16	0.059	0.020	
AVG.	1.17	0.44	51.7	5.13	7.1	5.87	3.57	43.69	0.073	0.024	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MAY 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	--	--	80	5	7.1	5.8	2	47.00	0.080	0.027	
2	--	--	80	5	7.1	5.8	9	46.31	0.080	0.027	
3	--	--	90	3	7.1	5.9	9	35.29	0.078	0.026	
4	--	--	60	3	7.1	6.0	9	41.31	0.078	0.026	
5	--	--	50	3	7.1	6.0	8	53.93	0.084	0.028	
6	--	--	50	3	7.1	5.8	9	54.71	0.086	0.029	
7	--	--	50	5	7.1	5.9	10	61.47	0.087	0.029	
8	--	--	50	5	7.1	5.8	10	53.11	0.091	0.030	
9	--	--	50	5	7.1	5.9	10	53.06	0.098	0.033	
10	--	--	50	5	7.1	5.6	10	53.94	0.099	0.033	
11	--	--	50	5	7.1	5.6	10	64.43	0.100	0.033	
12	--	--	50	7	7.1	5.65	10	64.87	0.095	0.032	
13	--	--	50	10	7.1	5.85	10	57.27	0.106	0.035	
14	--	--	50	5	7.1	6.0	10	53.50	0.104	0.035	
15	--	--	50	5	7.1	5.8	10	52.08	0.096	0.032	
16	--	--	50	5	7.1	5.9	10	61.13	0.090	0.029	
17	--	--	50	5	7.1	5.9	10	68.92	0.095	0.032	
18	--	--	50	5	7.1	5.9	10	46.59	0.087	0.029	
19	--	--	50	5	7.1	5.9	11	69.07	0.100	0.033	
20	--	--	50	5	7.1	5.9	11	28.92	0.110	0.036	
21	--	--	50	5	7.1	5.8	12	47.12	0.084	0.028	
22	--	--	50	5	7.1	6.0	12	54.43	0.084	0.028	
23	--	--	50	5	7.1	6.0	12	56.72	0.089	0.030	
24	--	--	50	5	7.1	6.0	12	54.78	0.094	0.031	
25	--	--	50	5	7.1	5.9	12	55.60	0.099	0.033	
26	--	--	50	5	7.1	6.0	12	55.60	0.097	0.032	
27	--	--	50	5	7.1	5.9	12	55.21	0.114	0.038	
28	--	--	50	5	7.1	6.2	12	45.67	0.087	0.029	
29	--	--	40	5	7.1	6.0	12	55.08	0.107	0.036	
30	--	--	50	5	7.1	6.0	12	54.35	0.104	0.085	
31	--	--	--	--	--	--	--	44.33	0.090	0.030	
MAX.	--	--	90	10	7.10	6.20	12	69.07	0.114	0.038	
MIN.	--	--	40	3	7.10	5.60	2	28.92	0.078	0.026	
AVG.	--	--	53.3	4.97	7.10	5.89	10.3	53.79	0.093	0.031	

R = Raw prechlorinated water Source: Plant records

T = Treated water

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JUNE 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	--	--	40	5	7.1	6.0	12	41.62	0.085	0.028	
2	--	--	40	5	7.1	6.0	14	62.12	0.092	0.031	
3	--	--	40	5	7.1	6.0	14	58.17	0.100	0.033	
4	--	--	40	5	7.1	6.0	14	43.26	0.101	0.034	
5	--	--	40	5	7.1	6.0	18	41.47	0.085	0.028	
6	--	--	40	5	7.1	6.0	20	49.79	0.068	0.023	
7	--	--	40	5	7.1	6.0	20	53.71	0.081	0.027	
8	--	--	40	5	7.1	5.9	22	54.92	0.095	0.032	
9	--	--	40	5	7.1	6.2	22	55.39	0.112	0.037	
10	--	--	40	5	7.1	5.9	23	63.23	0.105	0.035	
11	--	--	40	5	7.1	5.9	23	54.26	0.094	0.031	
12	--	--	40	5	7.1	6.0	23	63.28	0.105	0.035	
13	--	--	40	5	7.1	6.0	24	50.60	0.100	0.033	
14	--	--	40	5	7.1	5.9	22	68.78	0.098	0.033	
15	--	--	40	5	7.1	6.0	19	54.17	0.090	0.030	
16	--	--	40	5	7.1	5.9	19	67.71	0.107	0.036	
17	--	--	40	5	7.1	5.9	18.5	56.62	0.110	0.037	
18	--	--	40	5	7.1	5.9	18	59.96	0.083	0.028	
19	--	--	40	5	7.1	5.9	18	67.47	0.094	0.031	
20	--	--	40	5	7.1	5.9	18	54.23	0.083	0.028	
21	--	--	40	5	7.1	6.0	18	61.01	0.089	0.030	
22	--	--	45	5	7.1	6.0	19	51.37	0.0813	0.027	
23	--	--	45	5	7.1	6.0	19	56.42	0.086	0.025	
24	--	--	45	5	7.1	6.0	19	57.95	0.113	0.038	
25	--	--	100	5	7.1	5.9	19	62.77	0.086	0.029	
26	--	--	80	5	7.1	5.9	16	65.56	0.101	0.034	
27	--	--	100	5	7.1	5.9	17	69.40	0.112	0.037	
28	--	--	100	5	7.1	6.0	16	61.83	0.107	0.036	
29	--	--	100	5	7.1	5.9	16	62.19	0.105	0.035	
30	--	--	60	5	7.1	5.8	18	70.52	0.090	0.030	
31											
MAX.	--	--	100	5	7.10	6.20	24	70.52	0.113	0.038	
MIN.	--	--	40	5	7.10	5.80	12	41.47	0.068	0.023	
AVG.	--	--	50.5	5	7.10	5.96	18.62	57.24	0.094	0.031	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JULY 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	--	--	60	5	7.1	5.9	24	54.59	0.097	0.032	
2	--	--	60	5	7.1	6.0	24	59.80	0.067	0.022	
3	--	--	60	10	7.1	6.0	24	51.16	0.095	0.032	
4	--	--	60	5	7.1	6.2	24	59.00	0.085	0.028	
5	--	--	60	5	7.1	5.9	24	57.43	0.089	0.030	
6	--	--	60	5	7.1	5.9	23	54.78	0.098	0.033	
7	--	--	60	5	7.1	6.0	23	54.60	0.088	0.029	
8	--	--	60	5	7.1	6.0	18.5	60.06	0.099	0.033	
9	--	--	55	5	7.1	6.0	19	49.80	0.086	0.029	
10	--	--	50	5	7.1	5.9	19	69.56	0.080	0.027	
11	--	--	50	5	7.1	6.0	20	63.51	0.075	0.025	
12	--	--	50	5	7.1	5.95	20	68.24	0.077	0.026	
13	--	--	50	5	7.1	6.05	20	63.01	0.094	0.031	
14	--	--	50	5	7.1	5.9	20	55.83	0.106	0.035	
15	--	--	40	5	7.1	5.9	20	56.88	0.111	0.037	
16	--	--	50	5	7.1	6.0	20	78.66	0.101	0.034	
17	--	--	50	5	7.1	6.0	21	109.00	0.094	0.031	
18	2.1	3.0	50	5	7.1	6.0	21	122.80	0.091	0.030	
19	2.3	2.2	50	5	7.1	5.9	21	114.40	0.090	0.030	
20	2.5	2.3	50	5	7.1	5.9	21	57.21	0.089	0.030	
21	2.2	1.1	45	5	7.1	5.9	21	62.82	0.097	0.032	
22	1.8	1.0	50	5	7.1	5.9	21	67.12	0.105	0.035	
23	1.9	0.92	55	5	7.1	5.9	22	56.75	0.082	0.027	
24	2.0	0.98	55	5	7.1	6.0	22	46.51	0.088	0.029	
25	1.8	0.92	55	5	7.1	6.0	22	49.79	0.093	0.031	
26	1.85	0.95	50	5	7.1	5.9	22	48.16	0.088	0.029	
27	1.9	0									
					.1	5.9	20	41.20	0.078	0.026	
29	1.9	0.98	50	5	7.1	6.0	21	52.86	0.102	0.034	
30	1.7	0.82	50	5	7.1	5.9	20	55.38	0.081	0.027	
31	1.7	1.4	50	5	7.1	6.0	20	43.51	0.082	0.027	
MAX.	2.5	3.0	60	10	7.10	6.20	24	122.80	0.111	0.037	
MIN.	1.7	0.65	40	5	7.10	5.90	18.5	41.20	0.067	0.022	
AVG.	1.96	1.29	52.74	5.16	7.10	5.95	21.24	59.59	0.089	0.030	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - AUGUST 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.9	1.1	40	5	7.1	6.0	23	44.20	0.083	0.026	
2	2.5	1.5	40	5	7.1	6.0	23	42.21	0.078	0.026	
3	2.3	1.9	55	10	7.1	6.0	23	38.85	0.077	0.026	
4	1.9	1.5	50	5	7.1	6.0	24	53.71	0.078	0.026	
5	1.7	1.5	50	5	7.1	6.0	24	58.82	0.088	0.029	
6	1.6	1.3	50	5	7.1	6.0	24	55.15	0.082	0.027	
7	1.6	0.95	50	5	7.1	6.0	24	48.81	0.083	0.028	
8	1.4	0.52	50	5	7.3	6.0	24	45.07	0.088	0.029	
9	1.6	0.6	50	5	7.3	6.1	24	53.10	0.087	0.029	
10	2.5	1.2	60	5	7.3	6.0	24	54.29	0.104	0.035	
11	1.6	0.35	60	5	7.3	6.0	24	57.32	0.112	0.037	
12	1.5	1.2	60	5	7.3	6.0	23	51.72	0.104	0.035	
13	1.9	1.8	60	5	7.1	6.0	24	43.51	0.076	0.025	
14	1.0	2.0	55	10	7.3	6.0	24	52.41	0.071	0.024	
15	1.7	1.3	50	5	7.4	5.9	24	41.86	0.084	0.028	
16	1.4	1.1	60	5	7.2	6.0	24	51.03	0.096	0.032	
17	1.4	0.92	60	5	7.1	6.0	24	54.19	0.086	0.029	
18	1.3	1.0	50	5	7.1	6.0	24	49.55	0.094	0.031	
19	1.3	0.63	50	5	7.1	6.0	24	53.91	0.091	0.030	
20	1.3	0.70	50	5	7.1	6.0	23	50.67	0.097	0.032	
21	1.2	0.98	50	5	7.1	6.0	22	47.91	0.088	0.029	
22	1.2	0.80	50	5	7.3	5.9	22	49.94	0.088	0.029	
23	1.2	0.99	50	5	7.1	6.0	21	49.14	0.090	0.030	
24	1.3	0.64	50	5	7.1	6.0	22	48.80	0.093	0.031	
25	1.3	1.7	50	5	7.1	6.0	21	60.54	0.086	0.029	
26	1.8	2.2	50	5	7.1	6.0	24	45.74	0.081	0.027	
27	2.1	1.8	50	5	7.1	6.0	24	58.82	0.086	0.029	
28	2.1	1.4	50	5	7.2	6.0	24	64.48	0.072	0.024	
29	2.2	1.2	50	5	7.2	6.0	24	47.53	0.066	0.022	
30	2.1	1.4	50	5	7.1	5.9	22	42.69	0.080	0.027	
31	2.0	0.95	50	5	7.1	6.0	22	53.54	0.097	0.032	
MAX.	2.5	2.2	60	10	7.4	6.0	24	64.48	0.112	0.037	
MIN.	1.2	0.35	40	5	7.1	5.9	21	38.85	0.066	0.022	
AVG.	1.71	1.20	51.6	5.32	7.16	5.99	23.3	50.48	0.088	0.029	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - SEPTEMBER 1984

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	1.85	0.54	50	5	7.1	6.0	22	62.58	0.096	0.032	
2	1.8	0.48	50	5	7.1	6.0	21	66.14	0.103	0.034	
3	2.0	0.72	50	5	7.1	6.0	21	64.14	0.093	0.031	
4	1.85	0.63	50	5	7.1	6.0	21	61.43	0.090	0.030	
5	1.8	0.68	50	5	7.2	6.0	21	52.88	0.094	0.031	
6	1.8	1.0	45	5	7.1	6.0	21	60.76	0.090	0.030	
7	1.65	0.97	45	3	7.1	6.2	18	62.80	0.089	0.030	
8	1.75	1.0	50	5	7.2	6.0	20	53.67	0.090	0.030	
9	1.95	0.90	50	5	7.2	6.0	18	45.52	0.096	0.032	
10	2.4	1.15	50	5	7.2	6.2	24	43.83	0.090	0.030	
11	1.9	1.9	50	5	7.2	6.2	23	54.02	0.092	0.031	
12	2.3	1.0	50	5	7.2	6.0	23	52.40	0.090	0.030	
13	2.1	0.76	50	5	7.2	5.9	22	69.85	0.094	0.031	
14	2.1	0.75	45	5	7.2	6.0	18	52.4	0.094	0.031	
15	2.2	0 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	53.89	0.092	0.031	
16	2.0	0.64	50	5	7.1	6.0	18	60.16	0.106	0.032	
17	2.0	0.66	40	3	7.4	6.0	17.5	58.61	0.092	0.031	
18	2.0	0.82	40	3	7.2	6.0	17	64.20	0.100	0.033	
19	2.3	0.69	35	3	7.1	5.8	18	--	0.100	0.033	
20	1.26	0.70	35	3	7.1	5.8	18	--	0.105	0.035	
21	2.0	0.68	40	5	7.0	5.9	18	54.14	0.101	0.034	
22	2.0	1.0	40	5	7.0	6.0	18	54.62	0.103	0.034	
23	1.9	0.86	40	5	7.1	6.0	18	54.95	0.099	0.033	
24	2.0	0.77	40	5	7.0	5.9	18	54.62	0.104	0.035	
25	2.3	0.65	40	5	7.1	6.1	18	--	0.103	0.034	
26	2.1	0.65	40	3	7.1	6.0	16	--	0.1053	0.035	
27	2.0	0.82	40	5	7.0	6.0	16	--	0.107	0.036	
28	2.0	1.0	40	5	7.0	6.0	10	--	0.104	0.035	
29	1.9	1.25	40	5	7.0	5.9	10	--	0.096	0.032	
30	1.75	1.0	40	5	7.0	5.9	8	--	0.090	0.030	
31											
MAX.	2.4	1.9	50	5	7.4	6.2	24	69.85	0.109	0.036	
MIN.	1.26	0.48	35	3	7.0	5.8	8	43.83	0.090	0.030	
AVG.	1.97	0.85	44.5	4.6	7.12	5.99	18.32	57.13	0.098	0.033	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - OCTOBER 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.7	1.3	40	5	7.1	5.9	8	63.67	0.100	0.033	
2	1.8	1.2	40	5	7.1	6.0	8	64.23	0.104	0.035	
3	2.1	0.98	40	5	7.1	6.8	10	54.19	0.103	0.034	
4	2.2	1.0	40	5	7.1	5.9	10	62.80	0.099	0.033	
5	2.1	1.1	40	5	7.0	6.0	10	73.10	0.096	0.032	
6	1.7	0.85	40	5	7.1	6.0	10	63.50	0.103	0.034	
7	1.9	1.0	40	5	7.1	6.0	7	65.28	0.100	0.033	
8	1.8	1.4	35	5	7.1	6.0	7	62.06	0.092	0.031	
9	1.6	1.8	35	5	7.1	5.9	10	59.52	0.092	0.031	
10	1.8	1.9	35	5	7.0	6.0	10	74.95	0.094	0.031	
11	1.6	0.89	45	5	7.1	6.0	10	55.14	0.105	0.035	
12	--	--	--	--	--	--	--	53.83	0.102	0.034	
13	1.6	0.98	40	5	7.1	5.9	12	73.15	0.084	0.028	
14	1.7	1.2	37	5	7.1	6.8	14	63.73	0.109	0.036	
15	1.8	0.9	37	5	7.1	6.9	12	62.80	0.099	0.033	
16	1.8	0.95	40	5	7.1	6.8	12	72.40	0.098	0.033	
17	1.7	0.92	40	5	7.1	6.7	12	73.48	0.104	0.035	
18	1.6	0.87	40	5	7.1	6.6	12	55.90	0.107	0.036	
19	1.7	0.75	40	5	7.1	6.7	10	65.54	0.105	0.035	
20	1.7	0.98	40	5	7.1	6.6	10	75.08	0.106	0.035	
21	1.7	0.88	35	4	7.0	6.6	10	66.12	0.111	0.037	
22	1.8	0.78	30	3	7.1	6.7	10	63.35	0.105	0.035	
23	1.7	0.82	35	5	7.0	6.7	10	67.96	0.108	0.036	
24	1.5	1.1	30	3	7.0	6.7	10	69.01	0.107	0.036	
25	1.6	1.1	33	5	7.1	6.6	10	55.11	0.104	0.035	
26	1.45	1.0	35	5	7.0	6.8	6	69.40	0.108	0.036	
27	1.55	1.1	35	5	7.0	6.5	6	70.37	0.101	0.034	
28	2.2	1.5	40	5	7.1	6.7	6	73.81	0.103	0.035	
29	2.0	1.3	37	5	7.1	6.8	8	64.52	0.112	0.037	
30	2.8	1.25	40	5	7.1	6.6	2	63.54	0.111	0.037	
31	1.8	0.98	40	5	7.1	6.65	5	62.75	0.109	0.036	
MAX.	2.8	1.9	45	5	7.1	6.90	14	75.08	0.112	0.037	
MIN.	1.45	0.75	30	3	7.0	5.90	2	53.83	0.084	0.028	
AVG.	1.80	1.09	36.6	4.83	7.08	6.43	9.23	65.11	0.103	0.034	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - NOVEMBER 1984

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.2	1.3	40	5	7.1	6.2	6	61.98	0.104	0.035	
2	2.95	1.6	37	4	7.0	6.8	7	70.97	0.102	0.034	
3	2.4	1.8	40	5	7.1	6.6	6	60.93	0.100	0.033	
4	2.7	2.2	45	5	7.1	6.7	6	62.49	0.098	0.033	
5	2.65	2.2	45	5	--	6.7	4	57.69	0.093	0.031	
6	2.5	2.5	45	5	--	6.8	5	69.95	0.096	0.032	
7	2.0	2.4	45	10	--	6.8	4	51.59	0.099	0.033	
8	2.0	2.75	45	5	--	6.7	4	78.69	0.105	0.035	
9	1.65	1.6	45	5	--	6.8	4	71.36	0.110	0.037	
10	1.9	3.2	45	5	--	6.7	4	63.35	0.113	0.038	
11	1.6	2.9	45	5	7.0	6.6	4	54.02	0.113	0.038	
12	1.6	3.05	45	5	--	6.6	4	52.36	0.102	0.034	
13	1.6	4.0	45	5	7.0	6.6	4	58.31	0.090	0.030	
14	1.65	8.6	40	3	6.8	6.5	2	60.88	0.099	0.033	
15	1.65	2.95	40	5	--	6.8	3	62.26	0.103	0.034	
16	1.6	3.6	40	5	--	--	3	70.87	0.101	0.034	
17	1.55	2.4	40	5	--	--	2	69.28	0.101	0.034	
18	3.2	2.2	40	5	--	--	2	62.67	0.102	0.034	
19	2.2	2.6	40	5	--	--	2	--	0.097	0.032	
20	1.5	2.2	37	4	--	--	2	--	0.096	0.032	
21	1.4	2.1	35	5	--	--	4	52.96	0.103	0.034	
22	1.45	2.75	40	5	--	--	4	70.45	0.099	0.033	
23	1.5	2.3	40	5	--	--	3	70.25	0.098	0.033	
24	1.7	2.5	40	5	--	--	2	53.63	0.105	0.035	
25	1.55	2.2	40	5	--	--	6	69.26	0.101	0.034	
26	1.4	2.4	40	5	--	--	6	61.15	0.093	0.031	
27	1.65	1.7	40	5	--	--	6	70.37	0.103	0.034	
28	1.75	3.3	40	4	7.1	7.1	5	70.31	0.091	0.030	
29	2.25	1.6	45	5	7.1	7.1	4	61.07	0.1014	0.034	
30	1.7	1.45	40	5	7.1	6.9	4	70.95	0.102	0.034	
31											
MAX.	3.2	8.6	45	10	7.1	7.1	7	78.69	0.113	0.038	
MIN.	1.4	1.3	35	3	6.8	6.2	2	51.59	0.090	0.030	
AVG.	1.92	2.61	41.47	5	7.04	6.72	4.07	63.91	0.100	0.033	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - DECEMBER 1984

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.8	1.9	40	5	--	--	4	53.99	0.099	0.033	
2	1.5	2.2	40	5	--	--	4	61.03	0.096	0.032	
3	1.4	2.3	40	5	--	--	4	69.17	0.096	0.032	
4	1.2	2.0	40	5	--	--	4	60.19	0.098	0.033	
5	1.5	2.1	40	5	7.1	6.8	2	50.74	0.095	0.032	
6	1.6	2.6	40	5	7.0	6.65	2	51.88	0.098	0.033	
7	1.25	2.1	40	5	7.05	6.6	2	51.73	0.100	0.033	
8	1.15	1.85	40	5	7.1	6.7	2	68.69	0.103	0.034	
9	1.2	1.75	40	5	7.1	6.85	2	60.17	0.101	0.034	
10	1.2	2.2	40	5	7.1	7.0	2	59.92	0.102	0.034	
11	1.2	2.3	40	5	7.1	6.9	2	68.88	0.099	0.033	
12	1.3	2.7	40	5	7.1	6.8	2	61.85	0.096	0.032	
13	1.2	1.7	35	5	7.1	7.0	2	69.75	0.090	0.030	
14	1.2	1.75	40	5	7.1	6.9	3	60.69	0.089	0.030	
15	1.1	2.0	40	5	7.1	6.8	4	62.15	0.094	0.031	
16	1.2	2.0	40	4	7.1	6.8	4	61.48	0.090	0.030	
17	2.1	1.7	40	5	7.1	7.0	2	59.33	0.095	0.031	
18	1.35	1.9	40	5	7.1	7.0	2	61.47	0.093	0.031	
19	1.2	1.9	40	5	7.1	6.95	1	62.48	0.096	0.032	
20	1.0	1.6	40	5	7.1	6.9	2	61.52	0.091	0.030	
21	0.96	1.6	40	5	7.1	6.8	2	61.90	0.092	0.031	
22	1.0	1.9	40	5	7.1	6.85	2	61.89	0.092	0.031	
23	1.0	1.55	40	5	7.1	6.95	2	62.58	0.097	0.032	
24	1.0	1.6	40	5	7.1	6.8	2	69.95	0.097	0.032	
25	1.0	1.9	40	5	7.1	6.7	2	73.70	0.086	0.029	
26	1.2	1.8	40	5	7.1	6.75	1	61.49	0.104	0.035	
27	1.1	1.5	40	5	7.1	6.8	3	60.19	0.093	0.031	
28	1.1	1.9i	40	5	7.1	6.6	4	52.46	0.095	0.032	
29	1.3	2.45	40	5	7.1	6.6	4	43.17	0.090	0.030	
30	1.4	2.6	40	5	7.1	6.66	4	52.67	0.096	0.032	
31	1.1	2.1	35	5	7.1	6.4	3	64.79	0.086	0.029	
MAX.	2.1	2.7	40	5	7.1	7.0	4	73.70	0.104	0.035	
MIN.	0.96	1.5	35	4	7.0	6.4	1	43.17	0.086	0.029	
AVG.	1.25	1.96	39.7	4.97	7.09	6.80	2.61	60.68	0.095	0.032	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JANUARY 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.1	2.25	35	5	7.1	6.55	2	60.29	0.092	0.031	
2	1.1	2.2	37	5	7.05	6.85	1	55.79	0.096	0.032	
3	1.35	2.1	35	5	7.0	6.6	2	61.31	0.098	0.033	
4	1.2	2.0	30	5	7.0	6.75	2	70.51	0.098	0.033	
5	1.15	2.25	35	5	7.2	6.6	2	53.24	0.097	0.032	
6	1.2	2.2	35	5	7.02	6.6	2	62.62	0.096	0.032	
7	1.1	2.1	35	5	7.01	6.65	2	61.82	0.096	0.032	
8	1.2	2.1	35	5	7.2	6.7	2	54.10	0.095	0.032	
9	1.15	2.5	35	5	7.05	6.65	2	62.05	0.095	0.032	
10	1.2	2.45	35	5	7.05	6.5	2	69.38	0.095	0.032	
11	1.15	2.1	35	5	7.1	6.8	2	70.97	0.092	0.031	
12	1.2	2.45	35	5	7.1	6.7	2	56.01	0.092	0.031	
13	1.1	2.75	35	5	7.1	6.75	2	37.24	0.102	0.034	
14	1.1	2.8	35	5	7.05	6.75	2	52.55	0.095	0.032	
15	1.2	3.3	35	5	7.0	6.65	4	51.67	0.092	0.031	
16	1.1	3.25	35	5	7.0	6.65	3	60.66	0.093	0.031	
17	1.1	3.25	35	5	7.0	6.7	4	69.36	0.090	0.030	
18	1.45	3.5	35	5	7.0	6.65	4	51.59	0.089	0.030	
19	1.3	4.0	35	5	7.05	6.7	4	68.68	0.092	0.031	
20	1.3	2.5	35	5	7.0	6.65	3	69.75	0.093	0.031	
21	1.25	2.5	35	5	7.0	6.7	3	66.03	0.088	0.029	
22	1.15	2.0	35	6	7.0	6.5	4	60.88	0.090	0.030	
23	1.1	2.4	35	5	7.0	6.1	4	53.09	0.094	0.031	
24	1.2	2.8	35	5	7.0	6.7	4	62.58	0.093	0.031	
25	1.1	2.3	35	5	7.0	6.55	3	68.98	0.094	0.031	
26	1.0	1.95	35	5	7.0	6.9	2	58.78	0.096	0.032	
27	1.0	2.0	35	5	7.0	6.95	2	62.01	0.107	0.036	
28	1.0	2.8	35	5	7.0	6.95	2	70.69	0.091	0.030	
29	1.0	3.75	35	5	7.0	6.7	2	62.69	0.108	0.036	
30	1.0	2.0	35	5	7.0	6.85	2	71.11	0.090	0.030	
31	1.0	1.8	35	5	7.0	6.8	2	70.63	0.092	0.031	
MAX.	1.45	4.0	37	6	7.2	6.95	4	71.11	0.108	0.036	
MIN.	1.0	1.8	30	5	7.0	6.10	2	37.24	0.088	0.029	
AVG.	1.15	2.53	34.9	5	7.03	6.68	2.55	61.16	0.094	0.031	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - FEBRUARY 1985

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	1.0	1.8	35	5	7.0	6.85	2	63.99	0.095	0.032	
2	1.0	1.55	35	5	7.0	6.7	4	62.91	0.094	0.031	
3	1.0	1.55	35	5	7.0	6.8	4	73.46	0.095	0.032	
4	1.0	1.85	35	5	7.0	6.7	4	61.47	0.091	0.030	
5	1.0	1.75	35	5	7.0	6.7	4	61.61	0.090	0.030	
6	1.0	1.8	35	6	7.0	6.5	4	60.61	0.090	0.030	
7	1.0	2.35	40	5	7.0	--	2	61.33	0.093	0.031	
8	0.98	2.95	40	5	7.0	6.6	4	51.29	0.089	0.030	
9	0.98	2.2	35	5	7.0	--	2	50.82	0.092	0.031	
10	0.95	2.1	35	5	7.0	--	2	59.36	0.091	0.030	
11	1.95	2.1	35	5	7.0	--	2	57.32	0.089	0.030	
12	0.98	1.85	35	5	7.0	--	4	66.92	0.090	0.030	
13	0.89	2.0	35	5	7.0	6.8	4	52.31	0.092	0.031	
14	0.87	1.6	35	5	7.0	6.85	4	72.19	0.087	0.029	
15	0.89	1.85	35	5	7.0	6.8	4	61.31	0.091	0.030	
16	0.91	1.65	35	5	7.0	6.75	4	64.20	0.096	0.032	
17	0.92	1.6	35	5	7.0	6.65	4	63.22	0.096	0.032	
18	0.92	2.1	35	5	7.0	6.75	4	62.01	0.093	0.031	
19	0.90	1.9	35	5	7.0	6.8	4	66.55	0.002	0.031	
20	0.79	1.65	35	5	7.0	6.85	4	66.04	0.094	0.031	
21	0.81	1.75	35	5	7.0	6.85	4	66.94	0.088	0.029	
22	0.87	1.85	35	5	7.0	6.8	3	70.61	0.096	0.032	
23	0.96	2.1	35	5	7.0	6.75	3	70.79	0.092	0.031	
24	0.91	2.0	35	5	7.0	6.8	4	71.40	0.090	0.030	
25	0.89	1.8	35	5	7.0	6.7	3	72.59	0.098	0.033	
26	1.80	1.95	35	5	7.0	6.7	3	72.94	0.086	0.029	
27	0.86	2.4	35	5	7.0	6.9	4	69.07	0.083	0.028	
28	0.81	1.75	35	5	7.0	6.75	4	71.40	0.090	0.030	
29											
30											
31											
MAX.	1.95	2.95	40	6	7.0	6.90	4	73.46	0.098	0.033	
MIN.	0.79	1.55	35	5	7.0	6.50	2	50.82	0.083	0.028	
AVG.	0.99	1.92	35.36	5.04	7.0	6.75	3.50	64.41	0.092	0.031	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MARCH 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	0.82	1.6	35	5	7.0	6.9	4	71.50	0.093	0.031	
2	0.83	1.65	35	5	7.0	6.85	3	71.84	0.093	0.031	
3	0.89	1.9	35	5	7.0	6.9	2	78.58	0.089	0.030	
4	0.84	1.8	35	5	7.0	6.95	4	73.46	0.096	0.032	
5	0.86	1.9	35	5	7.05	7.0	4	52.28	0.090	0.030	
6	0.85	1.65	35	5	7.0	6.85	4	76.66	0.095	0.032	
7	0.80	1.65	35	5	7.0	6.8	4	67.47	0.101	0.034	
8	0.82	1.8	35	5	7.0	6.85	4	50.88	0.099	0.033	
9	0.79	2.0	35	5	7.0	6.8	4	75.82	0.099	0.033	
10	0.81	2.3	35	5	7.0	6.75	4	65.26	0.101	0.034	
11	0.81	2.55	35	5	7.0	6.7	4	63.17	0.100	0.033	
12	0.83	3.45	45	7	7.0	6.6	4	73.07	0.097	0.032	
13	0.82	4.4	43	10	7.0	6.85	4	72.98	0.097	0.032	
14	0.80	4.2	40	10	7.0	6.8	4	—	—	—	
15	0.77	1.7	40	5	7.0	6.8	4	—	—	—	
16	0.70	1.7	40	5	7.0	6.85	4	—	—	—	
17	0.66	1.6	40	5	7.0	6.9	4	—	—	—	
18	0.88	2.0	45	5	7.0	6.85	4	—	—	—	
19	0.95	1.95	47	4	7.0	6.8	4	—	—	—	
20	0.89	2.0	40	5	7.0	6.8	4	—	—	—	
21	0.96	1.75	40	5	7.0	6.7	6	—	—	—	
22	0.87	1.5	40	5	7.0	6.75	6	—	—	—	
23	1.0	1.6	40	5	7.0	6.75	6	50.25	—	—	
24	0.87	1.65	40	5	7.0	6.7	6	49.52	—	—	
25	0.81	1.65	40	5	7.0	6.7	6	46.45	—	—	
26	0.95	1.95	40	5	7.0	6.7	5	48.17	—	—	
27	1.65	2.35	43	5	7.0	6.75	5	43.37	—	—	
28	2.2	1.9	43	5	7.0	6.9	4	36.01	—	—	
29	1.7	2.2	43	5	7.05	6.6	6	55.29	—	—	
30	1.92	2.1	40	5	7.0	6.7	6	41.19	—	—	
31	1.01	2.0	40	5	7.0	6.9	6	47.09	—	—	
MAX.	2.2	4.4	47	10	7.05	7.0	6	78.58	0.101	0.034	
MIN.	0.66	1.5	35	4	7.0	6.60	2	41.19	0.089	0.030	
AVG.	0.98	2.08	39.16	5.35	7.0	6.80	4.48	55.62	0.096	0.032	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - APRIL 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	0.98	2.0	40	5	7.0	6.75	5	47.42	—	—	
2	0.90	1.9	40	5	7.0	6.8	5	47.02	—	—	
3	1.0	1.85	40	5	7.0	6.7	5	47.19	—	—	
4	1.5	1.75	45	5	7.0	6.75	5	35.71	—	—	
5	1.25	2.05	45	5	7.0	6.8	5	46.74	—	—	
6	1.1	1.65	40	5	7.0	6.5	5	59.99	—	—	
7	1.1	2.5	40	10	7.0	6.7	5	41.86	—	—	
8	1.0	2.1	40	5	7.0	6.9	5	41.44	—	—	
9	1.95	2.1	40	5	7.0	6.8	5	53.49	—	—	
10	1.1	2.1	40	5	7.0	6.8	5	53.02	—	—	
11	1.0	2.3	37	5	7.0	6.75	5	48.23	—	—	
12	1.25	2.0	35	5	7.0	6.75	5	51.77	—	—	
13	1.2	1.9	35	5	7.0	6.9	5	54.60	—	—	
14	1.0	2.25	35	5	7.0	6.5	5	47.99	—	—	
15	3.2	1.8	37	5	7.0	6.9	2	47.11	—	—	
16	2.5	1.5	35	5	7.0	6.95	2	53.21	—	—	
17	1.75	1.8	35	5	7.0	6.8	2	41.18	—	—	
18	1.15	1.95	35	5	7.0	6.85	3	41.55	—	—	
19	1.2	1.1	30	5	7.0	6.9	6	41.44	—	—	
20	2.1	1.4	35	5	7.0	6.85	6	45.64	—	—	
21	2.8	1.35	37	5	7.0	6.9	6	47.42	—	—	
22	5.85	1.35	30	5	7.0	6.9	7	41.22	—	—	
23	6.55	1.5	40	5	7.0	6.7	8	45.24	—	—	
24	5.8	1.35	40	5	7.0	6.95	8	35.69	—	—	
25	6.8	2.35	45	5	7.0	6.8	7	47.76	—	—	
26	9.0	2.4	45	5	7.0	6.8	7	46.78	—	—	
27	1.02	3.1	47	5	7.0	6.85	7	48.91	—	—	
28	4.0	3.0	50	5	6.05	6.8	7	32.66	—	—	
29	2.95	2.8	47	5	6.05	6.8	5	38.07	—	—	
30	3.4	2.9	47	5	6.05	6.75	5	35.44	—	—	
31											
MAX.	9.0	3.10	50	10	7.0	6.95	8	59.99	—	—	
MIN.	0.90	1.10	30	5	6.05	6.50	2	32.66	—	—	
AVG.	2.55	2.00	39.6	5.2	6.91	6.80	5.27	45.51	—	—	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MAY 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	4.2	3.0	50	5	6.05	6.8	5	35.79	--	--	
2	3.9	1.7	47	5	6.6	6.95	5	41.69	--	--	
3	3.9	1.5	40	5	6.8	6.85	5	41.64	--	--	
4	2.9	1.55	40	5	6.6	6.9	5	52.56	--	--	
5	2.6	1.35	40	4	6.6	6.6	6	48.04	--	--	
6	3.0	2.5	45	4	6.6	6.55	6	57.62	--	--	
7	2.9	2.2	40	5	6.6	6.4	6	--	--	--	
8	2.6	1.9	40	5	6.6	6.55	6	--	--	--	
9	2.9	1.65	40	5	6.6	6.5	6	--	--	--	
10	3.1	1.7	45	5	6.6	6.65	10	--	--	--	
11	2.7	2.1	45	5	6.6	6.75	6	--	--	--	
12	2.5	1.2	45	5	6.6	6.7	10	--	--	--	
13	2.0	1.6	45	5	6.6	6.8	10	--	--	--	
14	1.8	1.4	45	4	6.2	6.7	12	--	--	--	
15	--	--	--	--	--	--	--	--	--	--	
16	1.75	0.89	45	5	6.4	6.75	14	--	--	--	
17	2.6	0.85	45	5	6.4	6.7	14	--	--	--	
18	2.2	0.89	45	5	6.5	6.8	12	--	--	--	
19	2.0	0.95	45	5	6.4	6.9	12	--	--	--	
20	2.4	0.77	45	5	6.4	6.85	12	36.06	--	--	
21	2.5	0.83	45	5	6.5	6.9	14	48.29	--	--	
22	2.5	1.6	45	5	6.5	6.6	14	47.29	--	--	
23	3.4	1.3	45	4	6.5	6.7	14	55.53	--	--	
24	3.2	1.2	45	4	6.4	6.8	14	53.49	--	--	
25	2.8	1.3	45	4	6.3	6.8	14	84.48	--	--	
26	2.5	0.5	40	5	6.5	7.0	14	60.18	--	--	
27	2.2	0.75	45	3	6.3	7.0	14	90.59	--	--	
28	2.1	1.2	45	5	6.9	6.4	13	86.95	--	--	
29	2.0	1.8	45	5	6.5	6.4	12	75.30	--	--	
30	1.4	0.8	40	5	6.8	7.0	11	76.83	--	--	
31	1.65	0.95	45	4	6.5	6.8	11	93.07	--	--	
MAX.	4.2	3.0	50	5	6.9	7.0	14	93.07	--	--	
MIN.	1.4	0.50	40	3	6.05	6.4	5	35.79	--	--	
AVG.	2.61	1.40	43.9	4.70	6.52	6.74	10.23	59.54	--	--	

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JUNE 1985

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.2	0.63	45	5	6.4	7.0	11	—	--	--	
2	2.0	1.45	45	4	6.5	6.6	14	94.64	--	--	
3	2.5	1.9	40	5	6.6	6.3	22	100.20	--	--	
4	1.95	1.6	40	5	6.7	6.6	22	66.76	--	--	
5	1.8	0.9	40	5	6.5	7.0	22	56.16	--	--	
6	1.9	1.5	40	5	6.4	6.6	22	112.30	--	--	
7	1.9	0.69	45	5	6.5	6.6	22	77.08	--	--	
8	2.3	0.88	45	5	6.6	6.9	22	50.26	--	--	
9	2.1	1.1	45	5	6.5	6.9	23	63.97	--	--	
10	2.2	0.70	45	5	6.8	6.9	22	67.13	--	--	
11	2.2	0.69	45	3	6.8	6.9	22	74.81	--	--	
12	2.1	2.1	45	5	6.6	7.0	23	56.12	--	--	
13	1.7	2.6	40	5	6.5	6.9	23	66.02	--	--	
14	1.4	1.6	37	5	6.6	6.4	23	—	--	--	
15	1.4	2.3	40	5	6.8	6.7	23	93.15	--	--	
16	1.5	1.2	40	5	6.9	6.75	15	93.07	--	--	
17	1.8	2.6	40	5	6.8	6.65	13	92.99	--	--	
18	1.8	1.4	40	5	6.8	6.7	16	--	--	--	
19	2.6	0.82	40	5	6.6	6.9	16	23.96	--	--	
20	2.1	1.6	40	5	6.9	6.8	16	--	--	--	
21	2.0	2.5	40	5	6.8	6.8	16	--	--	--	
22	1.7	2.0	40	5	6.7	6.8	16	--	--	--	
23	2.4	0.56	40	4	6.7	6.9	22	--	--	--	
24	2.65	0.75	45	5	6.8	7.2	22	--	--	--	
25	2.4	0.65	40	5	6.9	6.6	22	--	--	--	
26	1.85	1.25	40	5	6.8	6.9	22	--	--	--	
27	1.65	2.55	40	5	6.8	6.9	24	84.77	--	--	
28	1.9	2.9	40	5	6.8	6.8	23	133.00	--	--	
29	1.6	0.60	40	5	6.8	6.9	19	--	--	--	
30	1.7	1.25	40	5	6.8	6.9	20	96.26	--	--	
31											
MAX.	2.65	2.90	45	5	6.9	7.0	24	133.00	--	--	
MIN.	1.40	0.56	37	3	6.4	6.3	11	23.96	--	--	
AVG.	1.98	2.07	41.4	4.87	6.69	6.79	19.93	79.51			

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JULY 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.6	1.25	40	5	6.8	7.0	24	70.65	--	--	
2	1.5	0.89	45	5	6.6	6.6	24	--	--	--	
3	1.3	0.84	40	5	6.6	6.8	24	20.47	--	--	
4	1.5	0.70	40	5	6.7	6.4	24	50.93	--	--	
5	1.35	0.82	40	5	6.9	6.7	24	--	--	--	
6	1.6	0.49	40	5	6.9	6.5	22	65.70	--	--	
7	2.0	0.45	40	5	6.7	6.7	20	36.57	--	--	
8	1.85	0.98	40	5	6.8	6.65	20	39.42	--	--	
9	1.7	3.0	60	5	6.7	6.7	20	40.29	--	--	
10	1.7	1.2	50	5	6.6	6.6	22	45.58	--	--	
11	1.5	0.48	50	5	6.7	7.0	22	34.87	--	--	
12	1.3	0.80	45	5	6.4	6.8	22	40.07	--	--	0.15
13	3.5	0.58	50	5	6.7	6.9	22	55.25	--	--	0.1
14	6.9	0.83	50	5	6.6	6.6	22	35.64	--	--	0.75
15	5.5	0.56	60	5	6.4	6.8	22	39.67	--	--	0.11
16	4.9	0.82	60	3	6.2	6.6	22	72.22	--	--	1.1
17	6.0	0.68	55	5	6.4	6.4	22	64.20	--	--	
18	6.4	0.59	60	5	6.6	6.8	22	65.37	--	--	
19	5.4	0.46	60	5	6.4	6.8	22	49.33	--	--	0.3
20	5.8	0.66	60	5	6.3	6.6	22	56.51	--	--	0.2
21	7.2	0.43	60	5	6.4	6.7	22	55.74	--	--	0.2
22	5.8	1.35	60	5	6.5	6.8	22	39.49	--	--	0.3
23	6.35	0.58	60	5	6.3	6.8	22	50.08	--	--	0.4
24	6.6	0.62	60	5	6.4	6.8	22	65.18	--	--	0.6
25	6.8	0.49	70	5	6.3	6.7	22	54.16	--	--	
26	6.2	0.84	60	5	6.3	6.4	20	53.90	--	--	0.5
27	3.9	0.98	60	10	6.3	7.1	20	47.16	--	--	
28	2.0	1.42	50	5	6.4	7.0	23	41.93	--	--	
29	1.45	0.61	50	5	6.4	6.85	23	40.56	--	--	
30	1.4	0.62	50	5	6.6	6.9	23	36.36	--	--	
31	1.4	0.65	50	5	7.0	6.8	22	54.86	--	--	
MAX.	7.20	3.00	70	10	7.0	7.1	24	72.22	--	--	1.1
MIN.	1.30	0.43	40	3	6.2	6.4	20	20.47	--	--	0.1
AVG.	3.63	0.83	52.10	5.10	6.55	6.74	22.1	48.17	--	--	0.393

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - AUGUST 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.2	0.5	50	5	6.5	6.9	21	33.37	--	--	
2	1.4	1.6	50	5	6.8	6.9	20	23.57	--	--	
3	1.2	3.3	50	5	6.8	6.9	21	22.31	--	--	
4	1.3	1.9	50	5	6.7	6.9	20	31.23	--	--	
5	1.3	1.25	50	5	6.8	7.0	21	9.09	--	--	
6	1.5	1.6	50	7	6.8	7.0	21	62.43	--	--	
7	2.2	2.6	50	10	6.7	7.0	21	44.70	--	--	
8	2.3	0.98	50	5	6.7	7.0	21	40.71	--	--	
9	1.5	1.9	40	5	6.7	7.2	20	29.75	--	--	
10	1.2	2.8	50	17	6.8	6.9	21	50.89	--	--	
11	2.6	1.2	50	5	6.6	7.1	21	47.81	--	--	
12	1.3	0.13	45	5	6.6	7.0	20	50.32	--	--	
13	1.2	0.48	45	5	6.7	7.1	20	49.03	--	--	
14	1.3	0.58	50	5	6.7	7.0	21	66.02	--	--	
15	1.5	0.92	50	5	6.7	6.85	21	48.67	--	--	0.4
16	1.6	1.2	50	5	6.7	7.0	20	49.21	--	--	0.45
17	1.2	1.1	50	5	6.6	7.1	20	49.24	--	--	0.5
18	1.4	0.60	45	5	6.8	7.2	26	49.36	--	--	0.5
19	1.6	0.62	45	5	6.8	6.9	26	49.24	--	--	0.2
20	1.3	0.44	45	5	6.7	6.7	26	80.98	--	--	0.35
21	1.2	0.41	45	5	6.8	6.8	26	65.37	--	--	0.3
22	1.4	0.42	45	5	6.4	7.0	26	65.18	--	--	0.18
23	1.9	0.29	45	5	6.4	7.0	26	67.78	--	--	0.12
24	2.1	0.56	45	5	7.0	7.0	22	81.47	--	--	
25	2.1	0.48	45	5	7.1	7.1	22	72.68	--	--	0.28
26	1.95	0.51	45	5	7.2	6.9	22	80.35	--	--	
27	1.7	0.53	45	5	7.2	7.1	21	66.30	--	--	
28	1.6	0.56	45	5	7.1	6.9	22	72.18	--	--	
29	1.6	0.28	45	5	7.0	7.0	22	35.41	--	--	0.1
30	1.6	0.24	45	5	7.0	6.9	20	33.17	--	--	0.080
31	1.4	0.22	40	5	7.1	6.9	18	51.00	--	--	0.060
MAX.	2.60	3.30	50	17	7.2	7.2	26	81.47	--	--	0.500
MIN.	1.20	0.22	40	5	6.4	6.7	18	9.09	--	--	0.060
AVG.	1.57	0.97	46.94	5.61	6.79	6.98	21.78	47.42	--	--	0.271

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - SEPTEMBER 1985

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.6	0.19	40	5	7.0	7.0	19	51.00	--	--	0.068
2	1.6	0.35	45	5	7.0	6.9	19	64.35	--	--	
3	1.2	0.33	35	5	6.8	6.8	18.8	65.02	--	--	
4	1.75	0.25	40	5	6.6	6.9	11	64.98	--	--	0.08
5	1.75	0.22	35	5	6.6	7.0	18	57.91	--	--	0.24
6	1.7	0.20	35	5	6.7	7.0	18	58.63	--	--	0.18
7	1.7	0.20	40	5	6.7	7.0	18.4	49.33	--	--	0.28
8	1.8	0.29	40	5	6.8	6.9	16	39.02	--	--	0.30
9	1.7	0.32	40	5	6.9	7.1	16	53.39	--	--	0.22
10	1.7	0.28	40	5	6.8	6.9	16	49.03	--	--	0.25
11	1.6	0.19	40	5	6.6	6.8	16	49.00	--	--	0.22
12	1.5	0.21	35	5	6.6	7.0	16	47.52	--	--	0.07
13	1.8	0.38	40	5	6.7	6.9	15	24.39	--	--	
14	1.8	0.32	40	5	7.0	6.9	14	25.22	--	--	
15	1.6	0.22	40	5	6.9	7.0	14	57.27	--	--	
16	1.7	0.22	40	5	6.6	7.0	16.2	49.39	--	--	
17	1.8	0.39	40	5	6.7	6.9	16	53.70	--	--	0.22
18	1.9	0.42	40	5	7.0	6.9	16	53.82	--	--	0.16
19	2.0	0.92	35	5	6.8	6.8	18	43.37	--	--	0.24
20	1.9	0.20	35	5	6.8	6.9	18	81.15	--	--	0.18
21	1.9	0.20	40	5	7.2	7.0	18	65.98	--	--	
22	1.9	0.85	40	5	7.1	7.0	18	42.77	--	--	0.21
23	1.9	0.24	40	5	6.9	7.2	15.5	62.44	--	--	0.1
24	1.9	0.28	40	5	7.1	6.9	17.4	56.23	--	--	0.02
25	1.9	0.34	40	5	7.1	6.65	17	70.44	--	--	0.04
26	2.8	0.26	35	5	7.1	6.9	16.6	47.23	--	--	0.02
27	2.5	0.80	35	5	6.8	6.8	15	48.51	--	--	
28	2.5	0.32	35	5	6.7	6.8	15.4	64.59	--	--	0.07
29	2.25	0.30	35	5	6.8	6.75	22	63.44	--	--	0.07
30	1.9	0.28	35	5	6.8	6.7	22	--	--	--	0.02
31											
MAX.	2.8	0.92	45	5	7.2	7.2	22	81.15	--	--	0.30
MIN.	1.2	0.19	35	5	6.6	6.65	11	24.39	--	--	0.02
AVG.	1.85	0.33	38.3	5	6.84	6.91	16.8	51.62	--	--	0.148

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - OCTOBER 1985

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	2.0	0.24	35	5	6.6	6.7	24	48.82	--	--	0.02
2	2.0	0.19	35	5	6.8	6.7	24	42.55	--	--	0.04
3	2.1	0.32	35	5	6.7	6.7	24	39.95	--	--	0.02
4	2.0	0.21	35	5	6.8	7.0	13	19.91	--	--	0.02
5	2.1	0.20	40	5	7.0	7.1	14	42.13	--	--	
6	2.0	0.22	40	5	6.5	6.5	12	37.15	--	--	
7	1.9	0.29	40	5	6.6	6.7	10.5	45.49	--	--	
8	1.9	0.22	40	5	7.0	6.8	11.7	44.07	--	--	0.02
9	2.0	0.26	40	5	6.8	6.8	11.5	30.16	--	--	0.06
10	2.0	0.27	45	5	6.7	6.8	11.7	37.66	--	--	0.08
11	2.1	0.26	40	5	6.7	6.6	11	41.58	--	--	0.09
12	2.0	0.46	40	5	6.7	6.6	11	49.89	--	--	0.05
13	1.9	0.31	45	5	6.7	6.9	11	25.00	--	--	
14	1.9	0.29	45	5	6.7	6.9	11	44.07	--	--	
15	2.1	0.27	45	5	7.3	7.1	8	35.69	--	--	
16	2.0	0.76	45	5	6.8	6.5	10	43.98	--	--	
17	1.8	0.32	45	5	6.7	6.55	10.3	35.90	--	--	
18	1.8	0.28	45	5	7.0	6.6	10.5	35.96	--	--	0.18
19	1.9	0.41	45	5	6.6	6.9	10.5	36.57	--	--	0.32
20	1.9	0.52	45	5	6.6	6.9	9	43.43	--	--	0.17
21	1.8	0.47	40	5	6.3	7.1	8.5	34.89	--	--	0.15
22	1.7	0.39	45	5	6.7	6.9	11.2	30.60	--	--	0.17
23	1.7	0.35	40	5	6.7	7.0	12	29.72	--	--	0.08
24	1.8	0.78	40	5	6.7	6.9	12	44.15	--	--	
25	2.0	0.52	40	5	6.7	6.8	12	30.10	--	--	0.07
26	2.4	0.69	40	5	6.7	6.9	12	35.22	--	--	0.07
27	2.2	0.60	40	5	6.8	6.8	10	77.26	--	--	0.09
28	2.0	0.52	40	5	6.9	7.0	10	54.31	--	--	0.09
29	1.9	0.65	45	5	6.7	7.2	8	42.16	--	--	0.08
30	2.0	0.48	45	5	6.5	6.6	9	50.22	--	--	0.04
31	1.9	0.4	45	5	6.9	7.0	9	--	--	--	0.05
MAX.	2.40	0.78	45	5	7.3	7.2	24	77.26	--	--	0.32
MIN.	1.70	0.19	35	5	6.3	6.5	8	19.91	--	--	0.02
AVG.	1.96	0.39	41.5	5	6.74	6.82	12.01	39.40	--	--	0.0914

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - NOVEMBER 1985

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.8	0.6	45	5	7.0	6.9	9	60.60	—	—	
2	1.6	0.57	45	5	6.7	6.9	8.5	39.40	—	—	
3	1.6	0.43	45	5	6.7	6.9	8.6	49.23	—	—	
4	2.2	0.45	45	5	6.6	6.9	9	43.94	—	—	0.08
5	2.3	0.35	45	5	6.8	6.8	9	42.18	—	—	0.02
6	2.1	0.49	45	5	6.4	6.4	9	42.78	—	—	0.06
7	1.7	1.9	45	10	6.6	7.8	9	55.43	—	—	0.05
8	1.6	2.3	50	10	6.8	6.8	8	46.82	—	—	0.06
9	1.6	1.5	45	7	6.6	7.1	5	42.93	—	—	0.48
10	1.5	3.5	45	10	6.7	6.9	5	42.35	—	—	
11	1.5	2.5	40	15	6.4	6.7	5.9	36.32	--	--	0.62
12	1.3	2.4	40	5	6.4	6.8	4.3	30.67	—	--	0.02
13	1.4	1.1	40	5	6.8	6.7	3.9	47.50	--	—	0.35
14	1.6	1.1	40	5	5.2	6.6	5.1	48.84	--	--	
15	1.8	0.5	40	5	5.9	6.8	2.9	36.72	—	--	0.13
16	1.4	0.5	40	5	6.3	6.9	4.9	34.66	--	--	0.17
17	1.4	0.5	40	5	6.0	6.7	5.2	36.25	--	--	
18	1.4	0.35	40	5	6.8	6.75	4.8	34.50	--	—	0.14
19	1.3	0.45	40	5	6.6	6.6	5.5	36.73	--	--	1.2
20	4.2	0.8	40	5	6.6	7.0	4.0	30.00	--	--	1.5
21	2.45	0.81	40	5	6.9	6.8	4.0	36.24	—	—	0.23
22	1.75	0.45	40	5	6.9	7.0	1.0	35.71	--	--	0.1
23	2.4	0.55	45	5	6.7	6.8	0.3	42.24	--	--	
24	1.4	0.78	45	5	6.8	6.9	0.3	36.11	--	--	
25	1.4	0.5	45	5	6.8	6.9	4.9	41.49	--	--	1.3
26	1.1	0.55	50	7	6.7	6.6	5.2	41.06	—	—	0.1
27	1.2	0.7	45	7	6.9	6.75	1.0	38.57	--	--	
28	1.2	0.48	50	10	6.8	6.7	1.0	41.75	--	—	0.07
29	1.3	0.55	45	8	6.8	6.7	1.0	30.29	--	--	0.05
30	1.2	0.72	45	7	6.8	6.6	1.0	37.18	--	--	0.02
31											
MAX.	4.2	3.50	50	15	7.0	7.8	9.0	60.60	—	--	1.50
MIN.	1.10	0.35	40	5	5.2	6.4	0.3	30.00	--	—	0.02
AVG.	1.69	0.95	43.5	6.37	6.60	6.82	4.88	40.51	--	--	0.321

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - DECEMBER 1985

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.3	0.53	45	10	6.8	6.6	1	15.98	--	--	0.02
2	1.1	0.64	45	7	6.8	6.7	1	27.39	--	--	0.05
3	1.3	0.42	45	10	6.8	6.6	1	44.89	--	--	0.15
4	1.2	0.32	45	8	6.8	7.0	1	43.01	--	--	
5	1.2	0.75	45	10	6.8	6.75	1	49.64	--	--	0.10
6	1.1	0.62	45	7	6.7	6.8	1	42.16	--	--	
7	1.1	0.60	45	10	6.8	6.9	1	48.67	--	--	0.16
8	--	--	--	--	--	--	--	50.64	--	--	
9	1.0	0.55	45	10	6.7	6.8	1	50.10	--	--	0.12
10	1.0	0.88	45	10	6.7	6.8	1	48.96	--	--	0.40
11	1.0	0.98	45	10	6.7	6.7	1	58.65	--	--	0.54
12	1.0	0.96	40	10	6.7	6.7	1	49.50	--	--	
13	1.0	0.55	45	10	6.7	6.8	1	36.45	--	--	0.22
14	1.0	0.56	45	10	6.7	6.7	1	50.41	--	--	
15	1.0	0.54	45	10	6.7	6.7	1	44.69	--	--	
16	1.0	0.69	50	10	6.7	6.8	2	62.48	--	--	
17	1.0	0.80	50	12	6.7	6.8	1	54.48	--	--	
18	1.0	0.67	45	10	6.6	6.9	0	55.38	--	--	0.15
19	1.0	0.78	45	12	6.7	6.9	1	54.07	--	--	
20	1.0	0.59	45	10	6.7	6.8	1	59.70	--	--	
21	1.0	0.93	45	10	6.7	6.9	1	55.32	--	--	
22	1.0	0.56	45	13	6.7	6.8	1	49.48	--	--	
23	1.0	0.89	45	15	6.8	6.8	1	54.01	--	--	0.13
24	1.1	0.75	45	12	6.8	6.8	1	55.24	--	--	
25	1.0	0.95	45	7	6.8	7.0	1	48.43	--	--	
26	1.0	0.88	45	7	6.8	6.8	1	49.04	--	--	0.05
27	1.0	0.72	45	7	6.8	6.9	1	48.68	--	--	0.02
28	1.0	0.55	45	10	6.8	6.9	1	62.46	--	--	0.05
29	1.0	0.54	40	5	6.8	6.9	1	54.48	--	--	0.05
30	1.0	0.49	40	5	6.8	6.9	1	55.75	--	--	0.05
31								53.00			
MAX.	1.3	0.98	50	15	6.8	7.0	2	62.48	--	--	0.54
MIN.	1.0	0.32	40	5	6.6	6.6	0	15.98	--	--	0.02
AVG.	1.05	0.68	44.83	9.55	6.74	6.81	1	46.67	--	--	0.141

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JANUARY 1986

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.1	0.65	35	4	6.9	6.8	1	48.43	0.13	0.04	
2	1.05	0.75	--	--	6.8	6.7	1	49.04	0.13	0.04	0.22
3	1.0	0.52	--	--	6.8	6.9	1	48.68	0.124	0.041	0.05
4	1.0	0.53	--	--	6.8	6.7	1	62.46	0.124	0.041	0.28
5	1.0	0.72	--	--	6.8	5.8	1	54.48	0.121	0.04	
6	1.1	0.68	--	--	6.8	6.85	1	55.75	0.124	0.044	
7	1.0	0.83	--	--	6.8	5.8	1	54.37	0.122	0.041	0.23
8	1.0	0.64	--	--	6.8	6.7	1	39.53	0.089	0.03	0.21
9	1.2	0.64	--	--	6.8	6.8	1	60.64	0.108	0.036	0.22
10	1.1	0.78	--	--	6.8	6.8	1	68.69	0.122	0.041	0.04
11	1.1	0.75	--	--	6.8	6.9	1	45.00	0.080	0.027	
12	1.1	0.70	--	--	6.8	6.9	1	41.88	0.124	0.041	
13	1.1	0.61	--	--	6.8	6.9	1	67.93	0.121	0.040	0.12
14	1.1	0.50	--	--	6.85	6.85	1	47.33	0.120	0.040	0.05
15	1.05	0.95	--	--	6.8	6.75	1	53.24	0.135	0.045	
16	1.0	0.73	--	--	6.8	6.85	1	52.53	0.137	0.045	
17	2.1	0.80	30	4	6.8	6.9	1	59.60	0.133	0.044	0.05
18	1.9	1.0	32	3	6.8	6.0	2	53.52	0.129	0.043	0.05
19	1.0	--	30	3	—	—	2	58.45	0.149	0.05	0.05
20	1.7	0.48	35	3	6.8	6.9	2	55.35	0.123	0.041	0.05
21	1.2	0.48	30	3	6.9	7.0	2	55.47	0.132	0.044	0.06
22	1.3	0.64	35	3	6.8	5.8	2	51.10	0.121	0.040	0.05
23	1.4	0.65	32	3	6.85	6.8	2	55.47	0.123	0.041	0.05
24	1.1	0.66	30	3	6.85	6.75	2	61.01	0.121	0.040	0.05
25	1.1	0.95	30	4.5	6.9	6.9	1	61.13	0.121	0.040	0.05
26	1.1	1.50	35	5	6.85	6.75	1	53.77	0.120	0.040	0.05
27	1.1	0.95	35	5	6.9	6.9	1	147.90	0.120	0.040	0.04
28	1.0	2.2	35	10	6.9	6.0	1	93.81	0.119	0.040	
29	1.0	0.45	30	5	6.9	6.8	1	71.01	0.115	0.038	0.07
30	1.1	0.75	30	5	6.8	6.8	1	54.70	0.122	0.041	
31	1.1	0.65	30	4.5	6.85	6.8	1	55.41	0.123	0.041	
MAX.	2.1	2.2	35	10	6.9	7.0	2	147.90	0.149	0.050	0.28
MIN.	1.0	0.45	30	3	6.8	5.8	1	39.53	0.08	0.027	0.04
AVG.	1.16	0.77	32.1	4.3	6.82	6.68	1.2	59.00	0.122	0.041	0.10

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - FEBRUARY 1986

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	1.0	0.63	30	5	6.5	6.9	1	55.27	0.123	0.041	0.09
2	1.0	0.55	30	5	6.85	6.85	1	53.71	0.119	0.040	0.15
3	1.1	0.57	30	5	6.9	6.9	1	53.10	0.118	0.039	0.20
4	1.1	0.52	30	5	6.85	6.85	2	55.38	0.123	0.041	
5	1.1	0.95	32	5	6.9	6.8	1	128.50	0.120	0.040	0.01
6	1.1	2.40	30	9	6.9	6.85	1	101.10	0.120	0.040	0.13
7	1.1	2.30	32	10	6.9	6.9	1	54.98	0.109	0.036	
8	1.0	2.2	33	7	6.9	6.8	1	63.48	0.125	0.042	
9	1.0	1.8	30	6	6.9	6.75	1	66.27	0.094	0.031	
10	1.0	1.7	30	5	6.9	6.9	1	72.34	0.083	0.028	
11	1.0	1.8	30	5	6.85	6.8	1	57.71	0.086	0.029	
12	1.0	2.3	30	5	6.9	6.9	1	57.22	0.086	0.029	
13	1.0	2.5	33	5	6.9	6.9	1	67.72	0.086	0.029	
14	0.95	0.8	35	3	6.9	6.9	1	53.21	0.084	0.028	
15	1.0	0.9	35	5	6.85	6.8	1	50.56	0.086	0.029	0.01
16	1.0	0.72	35	3	6.9	6.9	1	43.04	0.084	0.028	
17	1.0	0.56	35	5	6.9	6.85	1	52.82	0.084	0.028	0.04
18	0.95	0.9	35	5	6.9	6.8	1	54.01	0.086	0.029	0.03
19	1.0	0.5	35	5	6.9	7.0	1	53.29	0.100	0.033	0.02
20	1.0	0.52	30	5	6.9	7.0	1	40.25	0.085	0.028	0.04
21	1.0	0.65	30	5	6.9	6.8	1	53.39	0.085	0.028	0.03
22	1.0	0.77	30	5	6.9	5.85	1	52.76	0.084	0.028	0.04
23	--	--	--	--	--	--	--	59.71	0.084	0.028	
24	1.0	0.55	30	5	6.9	6.9	1	52.50	0.084	0.028	
25	1.0	0.57	35	3	6.9	6.85	1	53.39	0.084	0.028	
26	1.0	0.68	35	3	6.85	6.9	1	51.08	0.081	0.027	
27	1.0	0.8	35	3	6.9	6.9	1	74.42	0.086	0.029	0.25
28	1.0	0.53	35	3	6.85	6.9	1	53.71	0.084	0.028	0.03
29											
30											
31											
MAX.	1.1	2.5	35	10	6.9	7.0	2	128.50	0.125	0.042	0.25
MIN.	0.95	0.5	30	3	6.5	5.85	1	40.25	0.081	0.027	0.01
AVG.	1.01	1.10	32.2	5	6.87	6.85	1	60.07	0.096	0.032	0.08

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MARCH 1986

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.0	0.45	35	3	6.9	6.9	1	55.38	0.078	0.026	
2	1.0	0.45	35	3	6.9	6.9	1	50.44	0.091	0.031	
3	1.0	0.55	35	3	6.9	6.75	1	47.05	0.085	0.028	0.03
4	1.0	0.53	32	4	6.85	6.9	1	53.45	0.085	0.028	
5	1.0	0.57	30	3	6.9	6.8	1	51.18	0.081	0.027	
6	1.0	0.67	35	3	6.9	6.85	1	64.93	0.082	0.028	
7	1.0	0.58	30	3	6.9	6.8	1	51.60	0.082	0.027	
8	1.0	0.65	30	3	6.9	6.8	1	53.55	0.085	0.028	
9	1.0	0.65	30	3	6.9	6.85	1	51.95	0.082	0.028	
10	0.87	0.90	32	3	6.9	6.85	1	60.67	0.086	0.029	0.03
11	0.95	0.79	35	3	6.9	6.95	1	54.68	0.077	0.026	0.02
12	0.95	0.53	30	3	6.9	6.85	1	60.67	0.086	0.029	0.03
13	0.85	0.57	30	4	6.9	6.8	2	60.28	0.085	0.028	
14	0.85	0.75	30	4	6.9	6.9	2	53.10	0.084	0.028	
15	1.1	0.92	35	3	6.85	7.0	2	54.37	0.086	0.029	0.03
16	0.9	0.69	35	3	6.9	6.95	2	68.31	0.087	0.029	0.02
17	0.95	0.70	35	5	6.9	6.85	2	60.95	0.086	0.029	0.04
18	1.0	0.95	30	5	6.9	7.0	2	60.52	0.085	0.028	
19	1.0	1.8	30	5	6.9	6.9	2	58.92	0.089	0.030	
20	1.0	3.5	30	7	6.9	6.85	2	52.61	0.084	0.028	
21	0.93	3.5	30	6	6.9	6.85	2	65.28	0.083	0.028	
22	0.9	3.0	32	8	6.85	6.9	2	55.52	0.088	0.029	
23	0.9	2.5	35	7	6.9	6.9	2	44.52	0.094	0.031	
24	0.9	2.8	35	6	6.85	6.95	1	47.36	0.086	0.029	
25	0.9	2.9	35	8	6.9	6.85	2	41.15	0.087	0.029	0.10
26	0.9	2.8	35	7	6.9	6.8	2	55.82	0.077	0.026	
27	1.0	2.5	35	7	6.9	6.85	1	66.27	0.092	0.031	
28	1.0	2.5	35	7	6.9	6.9	1	54.93	0.085	0.028	
29	1.1	1.85	35	3	6.85	6.9	2	54.12	0.085	0.028	
30	1.2	1.10	35	3	6.9	6.9	2	57.80	0.085	0.028	
31	1.3	0.65	35	3	6.9	6.9	2	57.77	0.085	0.028	
MAX.	1.3	3.5	35	8	6.9	7.0	2	68.31	0.094	0.031	0.10
MIN.	0.85	0.45	30	3	6.85	6.75	1	41.15	0.077	0.026	0.02
AVG.	0.98	1.40	32.9	4.5	6.89	6.88	1.5	55.66	0.084	0.028	0.03

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - APRIL 1986

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.3	0.60	30	3	6.85	6.9	2	43.69	0.069	0.023	
2	3.5	0.55	35	3	6.9	6.85	2	40.00	0.073	0.024	
3	2.6	0.56	35	3	6.9	6.8	1	23.57	0.037	0.012	
4	1.6	0.96	35	3	6.9	6.85	1	32.84	0.052	0.017	
5	1.9	0.55	35	3	6.9	6.9	2	43.13	0.068	0.028	
6	2.4	0.78	35	3	6.9	7.0	2	49.29	0.078	0.026	
7	3.1	0.91	35	4	6.9	6.9	2	40.80	0.086	0.029	0.04
8	2.2	0.93	35	3	6.9	6.9	2	54.18	0.086	0.029	0.03
9	2.5	1.10	35	3	6.8	6.9	2	47.84	0.087	0.029	0.02
10	1.55	0.98	40	4	6.8	5.8	2	51.25	0.081	0.027	0.02
11	1.6	1.85	40	5	6.85	7.0	2	44.27	0.080	0.027	
12	1.6	1.65	40	5	6.85	6.9	2	39.09	0.083	0.028	
13	1.3	1.8	41	5	6.8	6.9	2	53.05	0.083	0.028	
14	2.2	2.4	45	7	6.85	6.9	2	39.51	0.081	0.027	
15	3.2	1.5	50	5	6.85	7.0	2	37.58	0.078	0.026	
16	2.3	1.3	49	5	6.8	6.9	2	51.92	0.078	0.026	
17	2.7	1.5	48	3	6.65	6.8	2	40.15	0.065	0.022	
18	3.45	1.6	50	5	6.7	7.0	2	54.09	0.100	0.033	
19	6.4	0.95	55	4	6.6	6.9	2	40.49	0.082	0.027	
20	--	--	--	--	--	--	--	51.77	0.081	0.027	
21	6.3	0.9	55	5	6.65	7.1	1	54.20	0.085	0.028	
22	4.6	1.3	55	6	6.6	5.7	1	40.35	0.085	0.028	
23	3.4	1.4	55	5	6.6	6.9	1	46.10	0.084	0.028	
24	2.8	1.0	50	3	6.6	7.05	1	41.24	0.140	0.047	
25	3.0	0.68	50	3	6.6	6.8	1	43.88	0.125	0.042	
26	3.3	0.76	50	4	6.6	7.0	1	41.19	0.140	0.047	
27	3.6	0.6	53	3	6.55	7.0	2	43.80	0.137	0.046	
28	3.95	0.85	55	3	6.6	7.0	3.5	37.55	0.117	0.039	
29	4.9	0.95	55	5	6.65	7.0	2	31.96	0.081	01027	0.08
30	3.95	0.49	55	5	6.6	6.95	2	42.31	0.107	0.036	0.03
31											
MAX.	6.4	2.4	55	7	6.9	7.1	3.5	54.20	0.140	0.047	0.08
MIN.	1.3	0.55	30	3	6.55	5.7	1	23.57	0.037	0.012	0.02
AVG.	3.04	1.08	44.8	4.1	6.75	6.85	1.8	42.18	0.088	0.029	0.04

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - MAY 1986

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	5.1	0.45	55	5	6.6	5.5	4.5	31.76	0.108	0.036	0.04
2	4.0	0.53	55	5	6.6	5.5	4	53.93	0.137	0.046	0.02
3	4.1	0.55	55	5	6.6	5.5	4	41.11	0.140	0.047	
4	3.85	0.53	55	5	6.6	6.9	4	39.59	0.134	0.045	
5	3.3	0.63	55	3	6.65	6.7	4	43.72	0.128	0.043	0.02
6	2.1	0.68	54	5	6.7	7.1	4	45.85	0.134	0.045	
7	2.3	0.70	50	5	6.65	6.8	4	54.76	0.140	0.047	
8	2.4	0.50	50	5	6.65	7.0	4	54.51	0.139	0.046	
9	2.1	0.52	50	5	6.6	6.95	4	53.58	0.136	0.045	0.25
10	2.1	0.53	50	5	6.65	7.0	4	54.90	0.140	0.047	
11	2.2	0.57	50	5	6.6	7.0	4	38.96	0.099	0.033	
12	2.1	0.6	50	5	6.7	5.3	5	35.25	0.102	0.034	0.16
13	2.7	0.63	53	5	6.7	6.95	5.5	75.57	0.102	0.034	
14	2.8	0.6	55	5	6.7	6.8	6	72.37	0.092	0.031	0.15
15	2.35	0.55	53	5	6.65	6.8	6	46.70	0.094	0.032	
16	2.4	0.35	50	4	6.65	6.9	6	38.71	0.098	0.033	0.28
17	2.3	0.42	49	5	6.8	6.9	6	41.36	0.105	0.035	
18	2.3	0.52	55	5	6.8	6.8	6	42.76	0.079	0.026	
19	2.2	0.55	55	5	6.7	6.7	6	37.76	0.145	0.048	
20	2.2	0.48	55	5	6.85	6.9	6	44.19	0.128	0.043	
21	2.1	0.3	55	5	6.8	6.9	10	33.46	0.097	0.032	
22	2.1	0.27	50	5	7.0	6.8	6	46.01	0.110	0.037	
23	1.85	0.26	50	5	7.1	7.0	10	41.36	0.112	0.037	
24	1.85	0.32	50	5	7.0	7.0	10	37.66	0.096	0.032	0.02
25	2.1	0.5	50	5	7.2	7.1	10	45.77	0.102	0.034	0.03
26	2.2	0.9	55	5	7.2	7.1	15	47.59	0.088	0.029	
27	1.8	0.38	50	5	6.8	6.9	20	43.27	0.085	0.027	
28	2.1	0.45	50	5	6.8	6.9	20	47.40	0.088	0.029	
29	2.0	0.48	50	5	6.9	6.9	20	44.49	0.075	0.025	
30	--	--	50	5	6.95	7.0	22	41.21	0.084	0.028	0.02
31	1.9	0.45	47.5	4	6.8	7.0	22	55.68	0.113	0.038	
MAX.	5.1	0.9	55	5	7.2	7.1	22	75.57	0.145	0.048	0.28
MIN.	1.85	0.26	47.5	3	6.6	5.3	4	31.76	0.075	0.025	0.02
AVG.	2.50	0.51	51.9	4.9	6.77	6.73	8.5	45.77	0.110	0.037	0.10

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JUNE 1986

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	1.85	0.41	50	5	6.8	6.9	22	59.62	0.134	0.045	
2	1.6	0.37	50	5	6.8	7.0	22	50.32	0.113	0.038	
3	1.7	0.37	45	5	6.85	6.95	22	50.98	0.130	0.043	0.08
4	1.7	0.37	45	5	6.85	7.1	22	28.93	0.118	0.039	0.06
5	1.85	0.38	45	5	6.85	6.9	22	37.17	0.108	0.036	0.08
6	1.7	0.35	45	5	6.9	6.85	22	42.38	0.096	0.032	
7	1.85	0.38	45	5	6.9	6.8	20	44.26	0.100	0.033	
8	2.3	0.36	45	5	6.85	6.8	20	56.73	0.144	0.048	
9	2.0	0.36	45	5	6.8	6.9	19	33.84	0.086	0.029	
10	2.0	0.42	42.5	5	6.85	6.9	20	43.75	0.089	0.030	
11	2.0	0.45	43	5	6.9	7.0	20	55.24	0.113	0.038	
12	2.0	0.46	45	5	6.8	6.9	20	43.97	0.099	0.033	
13	1.85	0.43	45	5	6.75	7.0	20	31.85	0.130	0.043	
14	1.95	0.38	45	5	6.7	7.0	20	20.92	0.108	0.036	
15	1.8	0.35	45	5	6.8	6.8	20	45.24	0.108	0.036	
16	2.1	0.38	50	5	6.85	6.8	20	38.58	0.121	0.040	0.04
17	2.0	0.47	50	5	6.85	6.85	20	46.43	0.119	0.040	
18	2.0	0.36	45	5	6.85	6.85	21	40.41	0.103	0.034	0.04
19	1.85	0.43	45	5	6.9	6.95	20	47.95	0.120	0.040	0.05
20	1.8	0.39	50	5	6.8	7.0	20	42.53	0.096	0.032	0.04
21	2.1	0.40	52	5	6.9	6.9	20	44.25	0.100	0.033	0.05
22	2.1	0.42	45	5	6.8	6.95	20	—	0.113	0.038	0.03
23	1.7	0.45	50	5	6.8	7.0	22	43.19	0.098	0.033	0.12
24	2.0	0.51	45	5	6.85	6.85	22	49.35	0.112	0.037	0.14
25	2.0	0.38	45	5	6.9	7.0	22	46.50	0.105	0.035	0.09
26	2.2	0.45	45	5	6.9	7.0	22	46.45	0.118	0.039	0.09
27	1.9	0.42	45	5	6.9	6.9	20	57.00	0.116	0.039	0.08
28	1.8	0.36	45	5	6.9	6.85	19	43.35	0.110	0.037	0.11
29	2.1	0.28	42	5	6.85	6.9	20	41.86	0.107	0.036	
30	2.0	0.32	40	5	6.9	7.0	20	41.58	0.094	0.031	
31											
MAX.	2.3	0.51	52	5	6.9	7.1	22	59.62	0.144	0.048	0.14
MIN.	1.6	0.28	40	5	6.7	6.8	19	20.92	0.086	0.029	0.03
AVG.	1.93	0.40	45.8	5	6.85	6.92	20.6	43.60	0.110	0.037	0.07

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - JULY 1986

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.1	0.32	40	5	6.9	6.85	22	43.64	0.098	0.033	
2	2.1	0.36	45	5	6.9	6.8	22	51.69	0.131	0.044	0.06
3	2.1	0.31	45	5	6.8	6.9	22	45.37	0.116	0.039	0.06
4	2.2	0.36	45	5	6.8	6.9	21	52.90	0.119	0.040	
5	1.95	0.27	45	5	6.8	6.8	21	47.29	0.120	0.040	
6	1.95	0.24	50	5	6.8	6.9	21	38.46	0.087	0.029	0.02
7	1.95	0.48	50	5	6.9	6.9	21	34.91	0.071	0.024	0.03
8	1.9	0.46	50	5	6.95	6.75	22	39.06	0.072	0.024	0.02
9	2.6	0.42	50	5	6.95	6.8	22	42.33	0.078	0.026	0.01
10	2.75	0.33	45	5	6.9	6.9	22	38.92	0.079	0.026	
11	2.5	0.43	45	5	7.0	7.0	22	40.22	0.082	0.027	0.07
12	2.4	0.35	45	5	7.1	7.1	22	42.60	0.086	0.029	0.05
13	2.4	0.26	45	5	7.0	7.0	22	41.79	0.085	0.028	0.06
14	2.4	0.21	45	5	7.0	7.0	22	43.71	0.081	0.027	0.065
15	2.3	0.33	45	5	7.0	6.9	24	34.31	0.082	0.027	0.06
16	2.3	0.52	45	7	7.0	6.95	24	38.58	0.065	0.022	0.12
17	2.5	0.66	45	6	7.1	7.1	22	40.82	0.069	0.023	0.10
18	2.55	0.53	45	5	7.0	7.0	22	48.77	0.077	0.026	0.12
19	2.5	0.26	40	5	7.0	7.0	22	42.11	0.095	0.032	
20	3.0	0.24	40	5	6.85	7.0	22	46.76	0.119	0.040	
21	2.85	0.28	45	5	7.0	7.1	22	31.03	0.090	0.030	0.09
22	2.65	0.18	45	5	7.0	7.0	22	37.69	0.085	0.028	0.09
23	2.4	0.33	40	5	7.1	7.0	22	42.92	0.080	0.027	0.06
24	2.5	0.28	40	5	7.0	6.85	22	42.23	0.095	0.032	0.08
25	2.5	0.23	40	5	7.0	7.05	22	33.11	0.075	0.025	0.09
26	2.55	0.29	40	5	7.0	7.05	22	33.00	0.084	0.028	0.08
27	2.5	0.44	40	5	7.0	6.9	22	37.95	0.079	0.026	0.12
28	2.45	0.35	40	5	7.0	7.0	22	43.81	0.099	0.033	0.12
29	2.3	0.21	40	5	7.0	6.9	22	36.09	0.086	0.029	0.01
30	2.3	0.43	40	5	6.95	7.0	22	34.78	0.083	0.028	0.03
31	2.25	0.53	40	5	6.95	7.0	22	46.00	0.104	0.035	
MAX.	3.0	0.66	50	7	7.1	7.1	24	52.90	0.131	0.044	0.12
MIN.	1.90	0.18	40	5	6.8	6.75	21	31.03	0.065	0.022	0.01
AVG.	2.37	0.35	43.7	5.1	6.96	6.95	22	40.39	0.086	0.029	0.07

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - AUGUST 1986

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.4	0.27	40	5	7.0	7.0	24	42.97	0.097	0.032	0.02
2	2.35	0.22	40	5	7.0	6.95	24	62.82	0.142	0.047	
3	2.15	0.15	40	5	7.0	7.0	24	57.80	0.147	0.049	0.02
4	2.1	0.28	35	5	6.95	6.9	24	50.45	0.128	0.043	0.03
5	2.05	0.16	35	5	7.0	7.0	24	49.94	0.127	0.042	0.02
6	1.9	0.25	40	5	7.0	7.0	23	47.59	0.121	0.040	0.02
7	1.95	0.21	40	5	7.0	6.95	22	30.27	0.089	0.029	0.04
8	2.0	0.39	40	6	7.0	6.9	21	55.17	0.112	0.037	0.02
9	2.1	0.26	40	5	7.0	6.9	20	36.23	0.092	0.031	0.03
10	2.7	0.22	40	5	7.0	6.95	20	36.80	0.110	0.036	0.05
11	10.2	0.30	50	5	6.9	7.05	20	47.27	0.120	0.040	0.03
12	7.8	0.59	65	7	6.9	7.1	21	29.20	0.119	0.040	0.08
13	6.6	0.35	55	3	6.9	7.05	21	35.31	0.142	0.047	0.04
14	5.1	0.26	45	4	6.8	6.95	19	41.18	0.119	0.040	
15	3.3	0.34	45	4	6.8	7.0	20	59.22	0.120	0.040	0.07
16	3.0	0.25	45	5	6.8	6.95	20	29.28	0.099	0.033	0.08
17	2.7	0.30	42	3	6.75	6.9	20	48.25	0.122	0.041	0.08
18	2.65	0.35	40	5	6.85	6.95	20	31.59	0.080	0.027	0.08
19	2.4	0.32	40	5	6.9	6.95	20	42.16	0.086	0.029	0.09
20	2.35	0.20	40	5	6.95	6.9	20	45.41	0.092	0.029	0.09
21	2.0	0.25	40	3	6.8	6.85	20	27.43	0.093	0.031	0.07
22	2.2	0.38	40	3	6.85	6.95	21	46.43	0.118	0.030	
23	2.3	0.20	40	5	6.95	6.95	22	54.87	0.140	0.047	0.04
24	2.3	0.21	40	5	7.05	7.05	22	52.40	0.133	0.044	0.02
25	2.3	0.19	40	5	6.95	6.9	23	46.01	0.117	0.039	0.01
26	2.1	0.21	40	5	6.9	7.0	20	57.70	0.131	0.044	
27	2.0	0.27	40	3	6.95	7.1	16	46.98	0.119	0.040	
28	1.95	0.29	40	3	6.9	6.95	15	52.02	0.132	0.044 -	0.03
29	2.0	0.26	40	3	6.95	7.05	13	52.40	0.133	0.044	
30	2.0	0.21	40	5	6.9	6.9	16	45.94	0.134	0.045	0.02
31	2.4	0.21	40	5	6.9	7.0	19	52.02	0.132	0.044	0.02
MAX.	10.2	0.59	65	7	7.05	7.1	24	62.82	0.147	0.049	0.09
MIN.	1.90	0.15	35	3	6.75	6.85	13	27.43	0.080	0.027	0.01
AVG.	2.95	0.27	41.8	4.6	6.92	6.97	20.5	44.41	0.114	0.038	0.04

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - SEPTEMBER 1986

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.2	0.22	40	5	6.95	7.0	18	49.48	0.126	0.042	0.04
2	2.25	0.20	40	5	7.0	7.1	18	40.13	0.136	0.045	0.05
3	2.1	0.23	40	5	6.9	7.1	18	48.56	0.123	0.041	0.07
4	2.2	0.25	40	5	6.9	7.0	18	46.37	0.134	0.045	0.09
5	2.3	0.22	35	5	6.9	7.0	18	51.92	0.132	0.044	0.09
6	2.35	0.22	35	5	6.9	7.0	18	52.76	0.134	0.045	0.08
7	2.2	0.22	35	3	6.9	7.05	16	38.29	0.130	0.043	0.09
8	2.2	0.22	35	3	6.95	7.0	16	45.28	0.131	0.044	0.09
9	2.1	0.21	35	3	6.95	7.0	16	45.50	0.132	0.044	0.03
10	1.85	0.18	35	3	6.9	6.85	16	50.62	0.128	0.043	0.02
11	1.8	0.19	35	3	6.9	6.95	16	40.25	0.137	0.046	0.04
12	2.15	0.30	35	3	6.9	7.0	16	43.51	0.126	0.042	0.06
13	2.2	0.20	35	3	6.9	6.95	16	45.96	0.134	0.045	0.05
14	2.1	0.21	40	3	6.95	7.0	15	45.52	0.132	0.044	0.08
15	2.35	0.25	45	5	6.95	7.0	16	39.57	0.115	0.038	0.07
16	2.65	0.22	52	6	6.95	6.95	16	50.03	0.127	0.042	
17	2.45	0.20	55	5	6.9	7.0	14	59.56	0.134	0.045	0.11
18	3.1	0.22	50	5	6.9	7.0	11	51.47	0.131	0.044	
19	2.55	0.18	50	5	6.7	6.85	11	44.67	0.130	0.043	0.07
20	2.2	0.24	50	5	6.8	6.95	12	50.76	0.129	0.043	0.09
21	2.3	0.23	50	5	6.85	6.9	12	38.36	0.129	0.043	0.04
22	2.1	0.20	50	5	6.7	6.75	10	38.06	0.129	0.043	0.05
23	2.1	0.24	50	5	6.8	6.85	16	50.86	0.129	0.043	0.05
24	2.1	0.18	50	5	6.9	6.8	16	37.44	0.127	0.042	
25	2.0	0.12	32	5	6.9	6.45	16	38.20	0.129	0.043	0.04
26	1.9	0.17	40	5	6.85	6.8	16	36.52	0.124	0.041	0.04
27	1.85	0.15	40	5	6.8	6.75	15	47.38	0.137	0.046	0.05
28	1.9	0.23	40	5	6.9	6.7	14	44.23	0.128	0.043	0.04
29	1.8	0.19	40	5	6.85	7.0	16	35.69	0.121	0.040	0.07
30	1.9	0.20	40	5	6.8	7.0	16	49.68	0.126	0.042	0.06
31											
MAX.	3.1	0.30	55	6	7.0	7.1	18	59.56	0.137	0.046	0.11
MIN.	1.8	0.12	35	3	6.7	6.45	10	35.69	0.115	0.038	0.02
AVG.	2.18	0.21	41.6	4.5	6.88	6.93	15.4	45.15	0.129	0.043	0.06

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - OCTOBER 1986

	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
DATE	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	2.05	0.18	45	5	6.9	6.9	16	47.09	0.137	0.046	0.50
2	2.0	0.20	45	5	6.9	6.9	16	46.10	0.134	0.045	
3	2.0	0.25	45	5	6.8	6.9	15	49.64	0.126	0.042	
4	1.9	0.19	45	5	6.9	7.0	15	47.94	0.139	0.046	0.50
5	2.0	0.21	45	5	6.9	7.0	15	51.72	0.131	0.044	0.02
6	2.1	0.29	45	5	6.9	6.8	15	51.25	0.131	0.044	
7	2.1	0.20	45	5	6.9	7.1	4.3	41.55	0.113	0.038	
8	2.2	0.24	45	5	6.9	6.85	12	53.51	0.128	0.043	
9	2.3	0.22	45	3	6.9	6.9	12	57.57	0.130	0.043	0.02
10	2.15	0.25	45	3	6.9	6.55	12	59.30	0.134	0.045	
11	2.0	0.21	45	5	6.9	6.7	12	45.96	0.134	0.045	
12	2.2	0.20	45	5	6.9	7.2	12	47.05	0.137	0.046	
13	4.0	0.21	50	5	6.9	6.9	8	45.81	0.133	0.044	
14	2.9	0.32	60	5	6.9	6.9	11	52.71	0.134	0.045	0.02
15	3.0	0.39	60	5	6.9	7.0	11	40.80	0.140	0.047	0.03
16	3.0	1.20	60	10	6.9	6.95	11	52.84	0.134	0.045	
17	2.9	0.69	55	7	6.9	7.0	11	41.24	0.140	0.047	
18	2.0	0.65	55	7	6.9	6.95	15	52.61	0.134	0.045	0.04
19	1.95	0.51	55	5	6.9	6.95	15	45.85	0.133	0.044	0.03
20	1.95	0.40	50	5	6.8	6.95	15	45.17	0.131	0.044	
21	1.9	0.52	50	5	6.8	7.0	15	47.94	0.139	0.046	
22	1.95	0.42	50	5	6.8	7.0	15	39.17	0.133	0.044	0.06
23	1.8	0.99	50	7	6.8	7.1	15	54.20	0.138	0.046	
24	1.85	0.44	50	7	6.8	6.9	15	55.47	0.141	0.047	0.00
25	1.7	0.18	50	5	6.8	6.9	15	51.69	0.131	0.044	0.02
26	1.6	0.18	50	5	5.9	6.9	15	53.66	0.137	0.046	0.03
27	1.65	0.21	45	5	6.9	6.8	15	52.38	0.133	0.044	0.03
28	1.55	0.22	50	5	6.8	6.9	15	50.76	0.129	0.043	0.06
29	1.65	0.22	50	5	6.9	6.9	16	54.26	0.138	0.046	0.03
30	1.9	0.20	50	5	6.8	6.85	16	40.13	0.136	0.045	0.04
31	1.65	0.20	35	0	6.8	6.9	16	40.19	0.136	0.045	0.05
MAX.	4.0	1.20	60	10	6.9	7.2	16	59.30	0.141	0.047	0.50
MIN.	1.55	0.18	35	0	5.9	6.55	4.3	39.17	0.113	0.038	0.00
AVG.	2.13	0.35	48.9	5.1	6.84	6.92	13.59	48.87	0.134	0.045	0.09

R = Raw prechlorinated water Source: Plant records

T = Treated water

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - NOVEMBER 1986

DATE	TURBIDITY		COLOUR		pH		TEMP. °C	ALUM.	COAG. AID	FILT. AID	METAL RES. ALUM
	R	T	R	T	R	T	R	mg/L	mg/L	mg/L	mg/L
1	8.3	0.24	45	0	6.8	6.95	6	49.20	0.125	0.042	
2	3.5	0.23	70	5	6.8	6.9	6	38.75	0.143	0.048	
3	2.3	0.19	50	5	6.8	6.95	6	40.07	0.136	0.045	0.02
4	2.0	0.22	50	5	6.8	6.8	6	50.57	0.128	0.043	0.05
5	1.8	0.28	50	5	6.9	6.95	6	41.03	0.139	0.046	
6	2.5	0.26	50	5	6.9	6.9	6	43.39	0.126	0.042	
7	2.5	0.21	50	5	6.9	6.85	6	52.07	0.132	0.044	
8	2.7	0.32	50	5	6.9	6.9	6	51.37	0.131	0.044	0.03
9	1.9	0.38	50	3	6.9	6.9	7	63.22	0.126	0.042	0.04
10	3.0	0.68	50	5	6.9	6.85	4	51.54	0.131	0.044	
11	2.2	0.50	60	5	6.8	7.0	4	37.51	0.127	0.042	0.03
12	1.9	0.57	50	5	6.9	7.0	4	50.84	0.129	0.043	
13	1.75	0.92	50	5	6.9	6.95	4	79.38	0.134	0.045	
14	1.6	0.97	50	5	6.9	7.0	4	63.46	0.129	0.043	0.07
15	1.65	0.63	50	5	6.9	6.8	4	65.82	0.136	0.045	0.06
16	1.65	1.3	50	5	6.9	6.8	2	53.71	0.137	0.046	0.05
17	1.45	1.15	50	5	6.9	6.8	2	52.43	0.134	0.045	0.06
18	1.4	0.98	50	5	6.9	7.0	2	52.43	0.142	0.047	
19	1.4	0.63	50	5	6.9	7.0	2	37.38	0.113	0.038	0.04
20	1.35	0.68	45	5	6.9	7.0	2	52.22	0.133	0.044	0.08
21	1.4	0.95	50	5	6.9	7.0	2	39.34	0.134	0.045	0.10
22	1.4	0.70	50	5	7.0	7.0	2	46.63	0.135	0.045	0.10
23	1.45	0.64	50	5	6.9	6.9	2	47.26	0.137	0.045	0.08
24	1.4	0.51	45	5	6.9	6.9	2	39.75	0.134	0.045	0.08
25	1.4	0.56	45	3	6.9	6.8	2	31.94	0.130	0.043	
26	1.4	0.59	40	3	6.9	7.0	2	47.50	0.138	0.046	
27	1.3	0.85	40	3	6.9	6.75	2	46.24	0.134	0.045	
28	1.3	0.90	45	3	6.9	6.85	2	45.87	0.134	0.045	
29	1.25	0.50	40	3	6.9	6.95	2	52.76	0.134	0.045	
30	1.15	0.52	40	3	6.9	6.85	2	53.10	--	--	
31											
MAX.	8.3	1.30	70	5	7.0	7.0	7	79.38	0.143	0.048	0.10
MIN.	1.15	0.19	40	0	6.8	6.75	2	31.94	0.113	0.038	0.02
AVG.	2.01	0.60	48.8	4.37	6.89	6.91	3.52	49.23	0.133	0.044	0.06

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 2.1: PARTICULATE REMOVAL PROFILE - DAILY - DECEMBER 1986

DATE	TURBIDITY R	TURBIDITY T	COLOUR R	COLOUR T	pH R	pH T	TEMP. °C R	ALUM. mg/L	COAG. AID mg/L	FILT. AID mg/L	METAL RES. ALUM mg/L
1	1.2	0.51	45	5	6.9	6.8	1	52.35	0.134	0.045	
2	1.15	0.43	45	3	6.9	6.9	1	39.63	0.134	0.045	0.02
3	1.2	0.31	45	3	6.9	6.85	2	52.76	0.134	0.045	
4	1.25	0.20	40	3	6.9	6.8	2	53.50	0.134	0.045	
5	1.1	0.29	40	3	6.9	6.8	2	48.58	0.136	0.045	
6	1.15	0.25	45	3	6.9	6.8	2	43.47	0.123	0.041	
7	1.1	0.29	40	3	6.9	6.8	2	44.06	0.147	0.049	
8	1.15	0.29	40	3	6.9	6.9	2	39.38	0.128	0.043	
9	1.1	0.39	35	3	7.0	6.9	2	38.27	0.134	0.045	
10	1.1	0.38	40	3	6.9	6.9	2	46.05	0.130	0.043	
11	1.1	0.29	40	3	6.9	6.85	2	45.85	0.134	0.045	
12	1.0	0.30	40	3	6.9	6.85	2	45.99	0.133	0.044	
13	1.0	0.27	40	3	6.9	6.9	2	46.44	0.134	0.045	
14	1.0	0.28	40	3	6.9	6.9	2	35.60	0.135	0.045	
15	1.0	0.31	40	3	6.9	6.9	2	46.46	0.121	0.040	
16	1.0	0.43	40	3	6.9	6.85	2	46.65	0.135	0.045	
17	1.0	0.45	45	3	6.9	6.9	2	46.33	0.136	0.045	
18	1.1	0.35	43	3	6.9	7.0	2	45.78	0.134	0.045	
19	1.1	0.35	45	3	6.9	6.9	2	46.17	0.133	0.044	
20	1.0	0.34	45	3	6.9	6.9	2	45.92	0.134	0.045	
21	1.0	0.32	45	3	6.9	7.0	2	39.21	0.133	0.044	
22	1.0	0.27	45	3	6.9	6.85	2	39.24	0.133	0.044	
23	0.98	0.34	45	3	6.9	6.9	2	52.15	0.133	0.044	
24	1.0	0.36	40	3	6.9	7.0	2	46.19	0.134	0.045	
25	0.9	0.28	40	3	6.9	6.9	2	47.99	0.140	0.047	
26	1.0	0.28	40	5	6.9	6.9	1	53.47	0.136	0.045	
27	1.0	0.35	40	3	6.9	6.9	1	46.42	0.135	0.045	
28	0.95	0.48	40	3	6.9	6.9	1	59.48	0.134	0.045	
29	1.05	0.5	40	3	6.9	6.9	1	53.31	0.136	0.045	
30	1.0	0.58	40	3	6.9	6.85	1	53.58	0.136	0.045	
31	1.0	0.75	40	3	6.9	6.85	1	71.96	0.180	0.060	
MAX.	1.20	0.75	45	5	7.0	7.0	2	71.96	0.180	0.060	0.02
MIN.	0.90	0.20	35	3	6.9	6.8	1	35.60	0.121	0.400	0.02
AVG.	1.05	0.36	41.5	3.1	6.90	6.88	1.74	47.22	0.134	0.045	0.02

R = Raw prechlorinated water

T = Treated water

Source: Plant records

TABLE 3.0: DISINFECTION SUMMARY - MONTHLY FOR 1984, 1985 AND 1986

			1984			1985			1986		
			MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	Chlorine Dosage (mg/L)	R	1.4	0.9	1.2	2.5	1.8	2.2	2.7	1.6	2.1
		T	1.5	0.9	1.2	1.4	1.0	1.2	1.6	1.0	1.2
	Residual Chlorine Free	R	0.3	0.1	0.2	0.3	0.3	0.3	0.8	0.4	0.6
	(mg/L)	T	0.6	0.3	0.5	0.6	0.4	0.5	0.6	0.4	0.5
FEB	Chlorine Dosage (mg/L)	R	1.4	0.9	1.0	2.2	1.6	1.9	2.3	1.2	1.7
		T	1.5	0.9	1.1	1.5	1.1	1.3	1.7	0.9	1.3
	Residual Chlorine Free	R	0.3	0.2	0.2	0.4	0.3	0.3	0.8	0.5	0.6
	(mg/L)	T	0.6	0.4	0.5	0.6	0.4	0.5	0.6	0.5	0.5
MAR	Chlorine Dosage (mg/L)	R	1.3	0.9	1.1	2.0	1.3	2.2	3.6	1.3	1.9
		T	0.9	0.6	0.8	1.4	0.9	1.2	2.6	1.0	1.4
	Residual Chlorine Free	R	0.3	0.1	0.3	0.3	0.3	0.3	0.6	0.4	0.5
	(mg/L)	T	0.5	0.4	0.4	0.5	0.5	0.5	0.6	0.5	0.5
APR	Chlorine Dosage (mg/L)	R	1.3	0.8	0.9	3.0	1.2	1.9	4.0	1.4	2.6
		T	1.3	0.8	1.0	1.4	0.6	0.9	1.9	0.7	1.2
	Residual Chlorine Free	R	0.3	0.1	0.2	1.0	0.2	0.5	1.0	0.4	0.6
	(mg/L)	T	0.5	0.4	0.5	0.6	0.5	0.5	1.0	0.5	0.7
MAY	Chlorine Dosage (mg/L)	R	2.9	1.1	1.8	5.2	1.8	2.7	4.9	2.0	3.1
		T	3.0	1.2	1.9	3.3	1.1	1.6	2.3	1.0	1.5
	Residual Chlorine Free	R	0.8	0.1	0.3	1.2	0.6	0.9	1.0	0.3	0.7
	(mg/L)	T	0.6	0.4	0.5	0.6	0.2	0.5	1.0	0.7	0.9
JUN	Chlorine Dosage (mg/L)	R	2.8	1.4	2.2	11.0	1.3	6.9	5.2	2.4	3.1
		T	2.9	1.5	2.3	8.3	1.0	5.1	2.4	1.1	1.4
	Residual Chlorine Free	R	0.4	0.2	0.3	0.9	0.2	0.5	0.7	0.4	0.5
	(mg/L)	T	0.6	0.4	0.5	0.6	0.2	0.4	0.7	0.5	0.5
JUL	Chlorine Dosage (mg/L)	R	5.5	1.6	2.4	4.0	1.7	2.8	3.6	1.6	2.4
		T	5.8	1.7	2.5	3.6	1.5	2.6	2.1	1.0	1.4
	Residual Chlorine Free	R	0.4	0.1	0.2	0.5	0.2	0.4	0.6	0.2	0.4
	(mg/L)	T	0.6	0.4	0.5	0.6	0.3	0.5	0.7	0.3	0.5
AUG	Chlorine Dosage (mg/L)	R	1.0	0.3	0.6	3.9	1.4	2.4	3.7	1.9	2.9
		T	4.4	1.3	2.6	4.3	1.5	2.7	2.2	1.1	1.7
	Residual Chlorine Free	R	0.3	0.1	0.2	0.4	0.2	0.3	0.5	0.2	0.4
	(mg/L)	T	0.6	0.2	0.4	0.5	0.3	0.5	0.6	0.4	0.5
SEP	Chlorine Dosage (mg/L)	R	0.7	0.3	0.4	3.4	0.7	2.0	3.7	2.1	2.7
		T	4.3	1.7	2.5	3.7	0.8	2.2	2.2	1.2	1.6
	Residual Chlorine Free	R	1.0	0.3	0.4	0.4	0.3	0.3	0.6	0.2	0.5
	(mg/L)	T	0.6	0.4	0.5	0.6	0.5	0.5	0.6	0.4	0.5
OCT	Chlorine Dosage (mg/L)	R	2.5	1.6	1.9	1.9	0.9	1.3	3.7	1.3	2.7
		T	2.1	1.4	1.7	2.1	1.0	1.5	1.7	0.6	1.3
	Residual Chlorine Free	R	1.0	0.2	0.3	0.6	0.2	0.3	0.6	0.3	0.5
	(mg/L)	T	0.6	0.5	0.5	0.6	0.4	0.5	0.6	0.4	0.5
NOV	Chlorine Dosage (mg/L)	R	2.3	1.6	2.1	3.7	1.6	2.3	3.0	1.6	2.4
		T	1.6	1.1	1.5	2.2	0.9	1.4	1.4	0.8	1.1
	Residual Chlorine Free	R	0.3	0.2	0.3	1.1	0.3	0.7	0.6	0.3	0.5
	(mg/L)	T	0.5	0.4	0.5	1.1	0.4	0.6	0.6	0.5	0.5
DEC	Chlorine Dosage (mg/L)	R	2.5	1.5	2.1	3.2	1.3	2.4	2.8	1.7	2.3
		T	1.7	1.1	1.5	1.5	0.6	1.1	1.0	0.6	0.8
	Residual Chlorine Free	R	0.3	0.3	0.3	1.0	0.4	0.8	0.6	0.4	0.6
	(mg/L)	T	0.6	0.5	0.5	0.6	0.4	0.5	0.5	0.4	0.5

R = Pre-chlorination
T = Post-chlorination

Source: Plant records

NOTE: After Sept. 84, the pre-chlorination point was moved, resulting in a time delay of 3 to 6 minutes between application and sampling.

TIMMINS WATER TREATMENT PLANT

TABLE 3.1: DISINFECTION SUMMARY - DAILY BASIS 1984

			1	2	3	4	5	6	7	8	9	10	11	12	13
JAN	Chlorine Dosage (mg/L)	R	1.4	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.0	0.9	1.0	1.1	1.1
		T	1.4	1.2	1.1	1.1	1.2	1.1	1.1	1.2	1.0	0.9	1.0	1.2	1.2
	Residual Chlorine Free	R	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
	(mg/L)	T	0.45	0.5	0.5	0.5	0.4	0.3	0.4	0.5	0.4	0.5	0.4	0.35	0.4
FEB	Chlorine Dosage (mg/L)	R	1.0	1.0	1.1	1.4	1.1	1.0	1.1	1.1	1.4	0.9	1.3	0.9	1.1
		T	1.0	1.0	1.2	1.5	1.1	1.0	1.2	1.2	1.5	1.0	1.4	0.9	1.1
	Residual Chlorine Free	R	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2
	(mg/L)	T	0.4	0.5	0.5	0.5	0.5	0.55	0.45	0.4	0.5	0.5	0.5	0.5	0.45
MAR	Chlorine Dosage (mg/L)	R	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.3	1.1	1.0	1.1
		T	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.9	0.8	0.7	0.7
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.1	0.25
	(mg/L)	T	0.45	0.5	0.45	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.35	0.4
APR	Chlorine Dosage (mg/L)	R	1.0	0.9	0.9	0.9	1.0	0.9	1.0	0.9	1.0	0.9	0.9	0.9	1.0
		T	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.1	1.0	0.9	1.0	1.1
	Residual Chlorine Free	R	0.2	0.2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.2	0.2
	(mg/L)	T	0.45	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.45	0.4	0.45	0.5	0.45
MAY	Chlorine Dosage (mg/L)	R	1.1	1.3	1.3	1.4	1.5	1.6	1.9	2.2	2.0	1.4	1.4	2.3	2.9
		T	1.2	1.4	1.3	1.4	1.6	1.7	2.0	2.3	2.1	1.4	1.5	2.4	3.0
	Residual Chlorine Free	R	0.1	0.1	0.1	0.2	0.2	0.15	0.2	0.2	0.25	0.25	0.25	0.5	0.75
	(mg/L)	T	0.4	0.35	0.45	0.45	0.45	0.4	0.45	0.5	0.45	0.4	0.5	0.5	0.5
JUN	Chlorine Dosage (mg/L)	R	1.7	1.8	1.9	1.4	1.6	2.0	2.0	2.3	2.7	2.5	1.8	2.1	2.6
		T	1.8	1.9	2.0	1.5	1.7	2.1	2.1	2.4	2.8	2.6	1.9	2.2	2.7
	Residual Chlorine Free	R	0.15	0.2	0.2	0.2	0.2	0.3	0.15	0.25	0.35	0.3	0.25	0.35	0.3
	(mg/L)	T	0.4	0.45	0.4	0.45	0.45	0.45	0.45	0.4	0.5	0.55	0.5	0.5	0.5
JUL	Chlorine Dosage (mg/L)	R	2.5	1.7	2.4	2.3	2.4	2.7	2.6	2.6	2.4	2.1	2.2	2.1	2.1
		T	2.6	1.8	2.5	2.4	2.5	2.8	2.7	2.7	2.5	2.2	2.3	2.2	2.2
	Residual Chlorine Free	R	0.15	0.1	0.2	0.15	0.25	0.2	0.2	0.2	0.2	0.15	0.15	0.2	0.2
	(mg/L)	T	0.45	0.4	0.45	0.45	0.45	0.45	0.5	0.45	0.5	0.5	0.45	0.5	0.45
AUG	Chlorine Dosage (mg/L)	R	0.9	1.0	1.0	1.0	1.0	1.0	0.5	0.6	0.6	0.7	0.7	0.6	0.5
		T	3.8	4.0	4.4	4.2	4.2	4.3	2.2	2.3	2.3	2.8	3.0	2.7	2.2
	Residual Chlorine Free	R	0.3	0.2	0.15	0.15	0.2	0.2	0.1	0.1	—	—	—	—	—
	(mg/L)	T	0.4	0.45	0.35	0.35	0.5	0.4	0.4	0.3	0.2	0.4	0.4	0.4	0.4
SEP	Chlorine Dosage (mg/L)	R	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.5	0.4	0.4	0.3	0.4	0.3
		T	2.0	2.1	1.8	2.4	2.2	1.8	2.3	2.7	2.3	2.2	2.0	2.2	1.9
	Residual Chlorine Free	R	—	—	—	—	—	—	—	—	—	—	—	—	—
	(mg/L)	T	0.55	0.5	0.4	0.5	0.5	0.4	0.45	0.4	0.5	0.5	0.35	0.5	0.5
OCT	Chlorine Dosage (mg/L)	R	2.0	1.9	1.8	2.1	1.9	1.9	2.2	2.0	1.6	1.9	1.9	1.8	2.5
		T	1.7	1.6	1.6	1.8	1.6	1.6	1.9	1.7	1.4	1.6	1.6	1.6	2.1
	Residual Chlorine Free	R	1.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.25	0.2	0.2
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.45	0.45	0.45	0.45
NOV	Chlorine Dosage (mg/L)	R	2.3	2.3	1.6	1.8	2.3	1.9	2.2	1.6	2.3	2.0	2.3	2.1	2.0
		T	1.6	1.6	1.1	1.3	1.6	1.4	1.6	1.1	1.6	1.4	1.6	1.5	1.4
	Residual Chlorine Free	R	0.25	0.3	0.3	0.25	0.3	0.2	0.2	0.2	0.25	0.25	0.2	0.2	0.2
	(mg/L)	T	0.5	0.5	0.5	0.5	0.45	0.5	0.45	0.5	0.5	0.45	0.4	0.4	0.45
DEC	Chlorine Dosage (mg/L)	R	2.2	2.4	1.9	2.2	1.9	2.3	2.0	2.2	2.1	2.4	1.5	2.4	2.3
		T	1.5	1.7	1.3	1.6	1.3	1.6	1.4	1.6	1.4	1.7	1.1	1.7	1.6
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

R = Pre-chlorination
T = Post-chlorination

Source: Plant records

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MAX	MIN	AVG
1.2 1.2 0.25 0.5	1.2 1.2 0.2 0.5	1.1 1.1 0.2 0.45	1.1 1.1 0.3 0.6	1.0 1.1 0.1 0.45	1.3 1.4 0.15 0.5	1.3 1.3 0.2 0.5	1.1 1.2 0.25 0.5	1.3 1.3 0.2 0.45	1.2 1.2 0.3 0.5	1.3 1.3 0.3 0.5	1.2 1.3 0.2 0.5	1.3 1.3 0.2 0.5	1.2 1.3 0.2 0.5	1.3 1.3 0.1 0.45	1.3 1.4 0.2 0.5	1.4 1.5 0.2 0.5	1.2 1.3 0.2 0.4	1.4 1.5 0.3 0.6	0.9 0.9 0.1 0.3	1.2 1.2 0.2 0.5
1.1 1.1 0.2 0.45	1.0 1.1 0.2 0.4	1.0 1.0 0.2 0.5	0.9 1.0 0.3 0.5	1.2 1.3 0.3 0.5	1.0 1.1 0.2 0.5	1.1 1.1 0.3 0.5	1.0 1.0 0.3 0.5	0.9 1.0 0.3 0.55	0.9 0.9 0.2 0.5	1.0 1.0 0.3 0.5	1.0 1.1 0.3 0.5	1.0 1.1 0.3 0.5	0.9 0.9 0.3 0.5	0.9 0.9 0.3 0.5	0.9 0.9 0.25 0.45	— — — —	— — — —	1.4 1.5 0.3 0.6	0.9 0.9 0.2 0.4	1.0 1.1 0.2 0.5
1.1 0.8 0.25 0.4	1.1 0.8 0.25 0.4	1.0 0.7 0.25 0.4	1.1 0.8 0.2 0.4	1.0 0.7 0.3 0.45	0.9 0.6 0.3 0.4	1.1 0.8 0.3 0.5	1.0 0.7 0.3 0.5	1.2 0.9 0.3 0.4	1.0 0.7 0.3 0.5	1.3 0.9 0.3 0.5	1.1 0.7 0.25 0.5	1.2 0.8 0.25 0.45	1.2 0.8 0.25 0.5	1.1 0.8 0.25 0.5	1.1 0.7 0.2 0.5	1.1 0.7 0.25 0.4	1.9 1.4 0.25 0.4	1.3 0.9 0.3 0.5	0.9 0.6 0.1 0.4	1.1 0.8 0.3 0.4
0.9 1.0 0.2 0.5	1.0 1.0 0.25 0.5	1.0 1.0 0.2 0.5	0.9 1.0 0.15 0.4	0.9 1.0 0.1 0.4	1.1 1.2 0.1 0.45	1.0 1.1 0.1 0.4	1.0 1.0 0.1 0.45	0.8 0.8 0.15 0.45	0.8 0.9 0.1 0.4	0.9 0.9 0.1 0.4	0.9 0.9 0.1 0.4	1.0 1.1 0.1 0.45	1.3 1.3 0.2 0.5	1.0 1.1 0.1 0.5	0.9 0.9 0.2 0.45	0.8 0.8 0.1 0.45	— — — —	1.3 1.3 0.3 0.5	0.8 0.8 0.1 0.4	0.9 1.0 0.2 0.5
1.9 1.9 0.3 0.5	1.9 2.0 0.3 0.45	2.0 2.1 0.25 0.5	2.0 2.1 0.2 0.5	1.9 2.0 0.2 0.55	2.2 2.3 0.3 0.45	2.0 2.1 0.3 0.5	1.4 1.5 0.3 0.45	1.4 1.5 0.3 0.45	1.5 1.6 0.2 0.4	1.7 1.8 0.2 0.5	2.0 2.1 0.2 0.5	2.0 2.1 0.3 0.5	1.9 1.9 0.25 0.45	2.0 2.1 0.3 0.5	2.0 2.1 0.3 0.4	2.1 2.2 0.3 0.45	1.6 1.7 0.3 0.45	2.9 3.0 0.8 0.6	1.1 1.2 0.1 0.4	1.8 1.9 0.3 0.5
2.2 2.4 0.25 0.5	2.0 2.1 0.3 0.5	2.4 2.5 0.3 0.55	2.8 2.9 0.4 0.5	2.3 2.4 0.3 0.45	2.6 2.7 0.3 0.5	2.0 2.1 0.3 0.55	2.1 2.2 0.3 0.55	1.9 2.0 0.3 0.5	2.2 2.3 0.25 0.5	2.1 2.2 0.3 0.55	2.8 2.9 0.2 0.5	2.4 2.5 0.2 0.5	2.4 2.5 0.25 0.45	2.7 2.8 0.15 0.4	2.7 2.9 0.3 0.4	2.4 2.5 0.3 0.4	— — — —	2.8 2.9 0.4 0.6	1.4 1.5 0.2 0.4	2.2 2.3 0.3 0.5
2.2 2.3 0.25 0.5	2.8 2.9 0.25 0.5	3.0 3.2 0.25 0.4	4.6 4.9 0.2 0.35	5.5 5.8 0.2 0.35	5.1 5.4 0.25 0.45	2.9 3.1 0.25 0.45	2.8 2.9 0.2 0.5	2.3 2.4 0.3 0.5	2.2 2.3 0.35 0.55	2.1 2.3 0.3 0.45	2.3 2.4 0.3 0.45	2.1 2.2 0.3 0.45	2.0 2.1 0.4 0.45	1.6 1.7 0.3 0.5	1.9 2.0 0.3 0.4	2.3 2.5 0.35 0.5	2.5 2.6 0.25 0.4	5.5 5.8 0.4 0.6	1.6 1.7 0.1 0.4	2.4 2.5 0.2 0.5
0.6 2.4 — 0.35	0.6 2.5 — 0.4	0.5 2.2 — 0.4	0.6 2.4 — 0.45	0.5 2.1 — 0.5	0.5 2.2 — 0.55	0.5 2.2 — 0.55	0.5 2.1 — 0.45	0.5 2.2 — 0.4	0.5 2.1 — 0.4	0.5 1.9 — 0.5	0.7 2.7 — 0.45	0.6 2.4 — 0.45	0.5 2.3 — 0.45	0.3 1.3 — 0.6	0.5 2.1 — 0.4	0.5 2.0 — 0.4	0.4 1.8 — 0.5	1.0 4.4 0.3 0.6	0.3 1.3 0.1 0.2	0.6 2.6 0.2 0.4
0.3 1.9 — 0.55	0.3 1.7 — 0.55	0.3 1.9 — 0.45	0.5 2.8 — 0.5	0.4 2.3 — 0.55	— — 0.25 0.5	— — 0.3 0.55	0.6 3.7 0.35 0.55	0.7 4.0 0.3 0.5	0.7 4.3 0.3 0.45	0.7 4.0 0.3 0.5	— — 0.3 0.5	— — 0.3 0.55	— — 0.3 0.55	— — 0.3 0.5	— — 0.3 0.5	— — 1.0 0.45	— — — —	0.7 4.3 1.0 0.6	0.3 1.7 0.3 0.4	0.4 2.5 0.4 0.5
2.2 1.9 0.25 0.5	1.9 1.6 0.3 0.5	1.9 1.6 0.3 0.5	1.9 1.7 0.3 0.5	2.0 1.7 0.3 0.5	2.0 1.7 0.3 0.55	2.0 1.7 0.25 0.5	2.0 1.7 0.2 0.5	1.9 1.6 0.25 0.5	1.9 1.6 0.3 0.5	1.9 1.6 0.3 0.5	1.9 1.6 0.3 0.5	1.8 1.5 0.25 0.5	1.8 1.5 0.3 0.5	1.9 1.6 0.25 0.5	1.9 1.6 0.25 0.45	1.9 1.6 0.25 0.45	1.8 1.6 0.25 0.5	2.5 2.1 1.0 0.6	1.6 1.4 0.2 0.5	1.9 1.7 0.3 0.5
2.1 1.5 0.2 0.5	2.3 1.6 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	— — 0.3 0.5	— — 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.25 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.45	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	— — — —	2.3 1.6 0.3 0.5	1.6 1.1 0.2 0.4	2.1 1.5 0.3 0.5
2.2 1.6 0.3 0.5	2.3 1.6 0.3 0.5	1.9 1.4 0.25 0.5	1.9 1.3 0.3 0.5	1.9 1.4 0.3 0.5	2.0 1.4 0.3 0.5	1.9 1.4 0.3 0.5	2.0 1.4 0.3 0.5	2.0 1.4 0.3 0.5	2.0 1.4 0.3 0.5	1.9 1.4 0.3 0.5	2.0 1.4 0.3 0.5	2.5 1.7 0.3 0.5	2.0 1.4 0.3 0.5	2.1 1.5 0.3 0.5	2.1 1.5 0.3 0.5	2.1 .15 0.3 0.5	1.9 1.4 0.3 0.55	2.5 1.7 0.3 0.6	1.5 1.1 0.3 0.5	2.1 1.5 0.3 0.5

TIMMINS WATER TREATMENT PLANT

TABLE 3.1: DISINFECTION SUMMARY - DAILY BASIS 1985

			1	2	3	4	5	6	7	8	9	10	11	12	13
JAN	Chlorine Dosage (mg/L)	R	2.3	2.2	1.9	2.3	2.1	2.3	2.2	2.1	1.8	2.3	2.3	2.2	2.0
		T	1.3	1.3	1.1	1.3	1.2	1.3	1.2	1.2	1.0	1.3	1.3	1.2	1.2
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	(mg/L)	T	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
FEB	Chlorine Dosage (mg/L)	R	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.7	1.6
		T	1.4	1.3	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.3	1.2	1.1
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	(mg/L)	T	0.55	0.55	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
MAR	Chlorine Dosage (mg/L)	R	1.8	1.8	2.0	1.9	1.8	1.9	1.7	1.7	1.9	1.9	2.0	2.0	2.0
		T	1.3	1.3	1.4	1.3	1.2	1.4	1.2	1.2	1.3	1.3	1.4	1.4	1.4
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.25
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
APR	Chlorine Dosage (mg/L)	R	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.7	1.2	1.8
		T	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.9
	Residual Chlorine Free	R	0.3	0.3	0.25	0.25	0.25	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.45	0.5	0.5	0.5	0.5	0.45	0.5
MAY	Chlorine Dosage (mg/L)	R	2.5	2.4	2.2	2.3	1.9	2.1	—	—	—	—	—	—	—
		T	1.5	1.4	1.3	1.3	1.1	1.2	—	—	—	—	—	—	—
	Residual Chlorine Free	R	0.8	0.9	0.9	1.0	1.0	0.8	0.9	0.9	0.8	0.6	0.9	1.0	1.0
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.45	0.5	0.45	0.5	0.5
JUN	Chlorine Dosage (mg/L)	R	—	6.2	10.0	8.8	6.6	8.3	11.0	8.9	11.0	8.9	5.2	5.5	2.7
		T	—	4.6	7.3	6.5	4.8	6.1	8.1	6.5	8.3	6.5	3.8	4.0	2.0
	Residual Chlorine Free	R	0.9	0.6	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5
	(mg/L)	T	0.5	0.3	0.2	0.3	0.4	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.4
JUL	Chlorine Dosage (mg/L)	R	3.4	—	2.1	2.6	—	3.9	1.7	3.1	2.5	2.7	2.4	2.1	2.6
		T	3.1	—	1.9	2.4	—	3.5	1.5	2.8	2.3	2.4	2.1	1.8	2.1
	Residual Chlorine Free	R	0.4	0.4	0.4	0.5	0.4	0.4	0.5	0.2	0.2	0.3	0.3	0.3	0.4
	(mg/L)	T	0.4	0.45	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
AUG	Chlorine Dosage (mg/L)	R	2.2	1.6	2.0	2.3	1.8	3.8	3.2	3.3	2.3	3.0	2.0	2.3	2.1
		T	2.4	1.8	2.2	2.6	2.0	4.2	3.5	3.6	2.5	3.3	2.2	2.5	2.3
	Residual Chlorine Free	R	0.4	0.4	0.3	0.4	0.3	0.2	0.4	0.3	0.4	0.3	0.4	0.2	0.2
	(mg/L)	T	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.5	0.4	0.5
SEP	Chlorine Dosage (mg/L)	R	1.5	2.5	2.5	2.2	2.4	2.3	2.5	2.0	3.0	1.9	2.8	2.4	2.1
		T	1.6	2.7	2.7	2.4	2.5	2.5	2.8	2.2	3.3	2.1	3.0	2.7	2.3
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.35	0.3	0.3	0.3
	(mg/L)	T	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.45	0.5	0.5	0.5	0.5	0.5
OCT	Chlorine Dosage (mg/L)	R	1.2	1.2	1.3	1.1	1.2	0.9	1.2	1.1	1.2	1.1	1.4	1.6	1.2
		T	1.4	1.3	1.4	1.2	1.3	1.0	1.4	1.2	1.3	1.2	1.6	1.7	1.3
	Residual Chlorine Free	R	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3
	(mg/L)	T	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5
NOV	Chlorine Dosage (mg/L)	R	2.1	2.0	1.9	1.9	1.6	2.0	2.0	1.8	1.9	1.9	1.7	2.4	3.0
		T	1.3	1.2	1.1	1.1	0.9	1.2	1.2	1.1	1.1	1.1	1.0	1.4	1.8
	Residual Chlorine Free	R	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.9	1.0
	(mg/L)	T	0.4	0.45	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.7
DEC	Chlorine Dosage (mg/L)	R	—	1.3	2.3	2.6	2.5	2.3	2.6	2.4	2.7	2.6	2.5	2.6	2.6
		T	—	0.6	1.1	1.2	1.2	1.1	1.2	1.1	1.3	1.2	1.2	1.2	1.2
	Residual Chlorine Free	R	0.8	0.7	0.4	0.5	0.9	0.9	0.9	0.8	0.8	0.7	1.0	1.0	1.0
	(mg/L)	T	0.6	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6

R = Pre-chlorination
T = Post-chlorination

Source: Plant records

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MAX	MIN	AVG
2.5	2.4	2.1	2.2	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.3	2.3	2.1	2.3	2.2	2.2	2.0	2.5	1.8	2.2
1.4	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.1	1.4	1.0	1.2
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.5	0.5	0.5	0.5	0.45	0.45	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.6	0.4	0.5
1.7	1.8	1.9	1.9	2.0	1.8	2.2	2.1	2.1	2.2	2.1	2.2	1.6	1.8	1.8	—	—	—	2.2	1.6	1.9
1.2	1.2	1.3	1.3	1.4	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.2	1.3	1.3	—	—	—	1.5	1.1	1.3
0.3	0.3	0.3	0.3	0.3	0.3	0.35	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	—	—	—	0.4	0.3	0.3
0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	—	—	—	0.6	0.4	0.5
—	—	—	—	—	—	—	—	—	1.3	1.4	1.3	1.4	1.5	1.4	1.7	1.3	1.5	2.0	1.3	2.2
—	—	—	—	—	—	—	—	—	1.0	1.1	0.9	1.0	1.1	1.1	1.3	0.9	1.1	1.4	0.9	1.2
0.3	0.3	0.3	0.3	0.3	0.25	0.25	0.3	0.25	0.25	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.7	2.6	2.4	2.5	2.5	2.6	2.7	3.0	2.2	—	3.0	1.2	1.9
0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.7	1.3	1.2	1.1	1.2	1.2	1.2	1.3	1.4	1.0	—	1.4	0.6	0.9
0.3	0.3	0.3	0.45	0.4	0.3	0.3	0.3	0.3	1.0	1.0	1.0	1.0	1.0	1.0	0.4	1.0	—	1.0	0.2	0.5
0.5	0.5	0.45	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.45	0.5	—	0.6	0.5	0.5
—	—	—	—	—	—	2.5	2.7	2.8	3.6	3.2	1.8	2.1	2.4	3.0	2.1	4.1	5.2	5.2	1.8	2.7
—	—	—	—	—	—	1.5	1.6	1.7	2.1	1.9	1.1	1.2	1.4	1.8	1.2	3.2	3.3	3.3	1.1	1.6
1.0	0.8	0.8	0.8	1.1	0.7	0.7	0.7	0.7	0.6	1.0	1.0	0.8	1.2	0.8	0.8	0.6	0.8	1.2	0.6	0.9
0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.45	0.5	0.45	0.5	0.5	0.45	0.5	0.5	0.4	0.5	0.2	0.6	0.2	0.5
—	5.2	5.2	5.2	—	1.3	—	—	—	—	—	—	—	3.5	—	—	7.0	—	11.	1.3	6.9
—	3.8	3.8	3.8	—	1.0	—	—	—	—	—	—	—	2.5	—	—	5.1	—	8.3	1.0	5.1
0.7	0.5	0.3	0.4	0.5	0.2	0.4	0.5	0.4	0.4	0.5	0.4	0.6	0.5	0.3	0.5	0.4	—	0.9	0.2	0.5
0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.55	0.2	0.4	0.6	0.4	—	0.6	0.2	0.4
2.1	3.3	3.3	3.6	3.7	3.7	3.3	3.3	2.4	3.0	4.0	3.2	2.8	2.9	3.1	3.3	2.5	2.9	4.0	1.7	2.8
1.9	2.9	3.0	3.2	3.3	3.3	3.0	2.9	2.2	2.7	3.6	2.9	2.5	2.6	2.8	3.0	2.3	2.6	3.6	1.5	2.6
0.4	0.3	0.2	0.2	0.3	0.4	0.5	0.4	0.3	0.5	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.2	0.4
0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.5	0.45	0.5	0.6	0.4	0.5	0.3	0.4	0.5	0.5	0.4	0.6	0.3	0.5
2.7	3.3	3.9	2.5	3.2	2.2	3.0	3.0	3.0	2.8	2.8	2.0	2.5	2.8	2.0	1.4	1.8	1.5	3.9	1.4	2.4
2.9	3.6	4.3	2.8	3.5	2.4	3.3	3.4	3.3	3.1	3.0	2.2	2.7	3.1	2.2	1.5	2.0	1.6	4.3	1.5	2.7
0.2	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.4	0.2	0.3
0.5	0.45	0.5	0.5	0.5	0.45	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.5	0.5	0.3	0.5
0.7	2.5	3.4	2.6	2.6	1.9	2.4	2.2	1.7	2.1	1.7	1.7	1.5	1.5	1.9	2.0	—	—	3.4	0.7	2.0
0.8	2.7	3.7	2.9	2.9	2.1	2.6	2.5	1.9	2.3	1.9	1.9	1.7	1.7	2.1	2.2	—	—	3.7	0.8	2.2
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.35	0.4	0.4	0.3	0.3	—	0.4	0.3	0.3
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.55	0.55	0.5	0.6	0.55	0.5	0.55	—	0.6	0.5	0.5
0.9	1.4	1.3	1.3	1.9	1.9	1.5	1.9	1.3	1.3	1.5	1.7	1.7	1.6	1.6	1.4	1.5	—	1.9	0.9	1.3
1.0	1.6	1.4	1.5	2.1	2.0	1.6	1.3	1.5	1.4	1.6	1.9	1.9	1.8	1.8	1.6	1.6	—	2.1	1.0	1.5
0.3	0.2	0.2	0.2	0.2	0.6	0.3	0.3	0.25	0.3	0.2	0.22	0.2	0.3	0.4	0.3	0.3	0.3	0.6	0.2	0.3
0.5	0.4	0.4	0.5	0.5	0.6	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.4	0.4	0.5	0.6	0.4	0.5
3.1	3.1	2.4	1.9	2.5	2.6	3.0	3.7	2.6	2.6	2.7	2.6	2.3	2.3	2.1	1.8	1.6	—	3.7	1.6	2.3
1.8	1.8	1.4	1.1	1.5	1.5	1.8	2.2	1.6	1.6	1.6	1.5	1.4	1.3	1.2	1.1	1.0	—	2.2	0.9	1.4
1.0	0.8	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.1	1.0	0.7	0.8	0.8	0.8	—	1.1	0.3	0.7
0.6	0.6	0.7	0.5	0.6	0.5	0.7	1.0	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	—	1.1	0.4	0.6
2.4	2.7	2.7	2.0	2.8	2.6	3.2	2.3	2.3	1.9	3.0	2.1	2.3	1.9	2.3	2.7	2.2	2.7	3.2	1.3	2.4
1.1	1.3	1.3	0.9	1.3	1.2	1.5	1.1	1.1	0.9	1.4	1.0	1.1	0.9	1.1	1.3	1.0	1.3	1.5	0.6	1.1
1.0	1.0	0.8	0.8	1.0	0.7	0.9	0.9	0.9	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.6	0.6	1.0	0.4	0.8
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.4	0.5

TIMMINS WATER TREATMENT PLANT

TABLE 3.1: DISINFECTION SUMMARY - DAILY BASIS 1986

			1	2	3	4	5	6	7	8	9	10	11	12	13
JAN	Chlorine Dosage (mg/L)	R	2.0	2.2	1.8	2.1	2.6	2.0	2.4	1.6	1.7	2.4	1.4	2.2	2.1
		T	1.2	1.3	1.1	1.3	1.5	1.2	1.4	1.0	1.0	1.4	0.8	1.3	1.2
	Residual Chlorine Free	R	0.4	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6
	(mg/L)	T	0.45	0.45	0.5	0.4	0.45	0.5	0.5	0.5	0.4	0.5	0.5	0.4	0.5
FEB	Chlorine Dosage (mg/L)	R	1.4	1.9	1.4	1.7	1.8	2.3	2.1	1.3	2.1	1.2	1.9	1.6	1.7
		T	1.0	1.4	1.0	1.2	1.3	1.7	1.5	0.9	1.5	0.9	1.4	1.2	1.2
	Residual Chlorine Free	R	0.7	0.7	0.7	0.6	0.55	0.5	0.5	0.5	0.55	0.5	0.8	0.6	0.5
	(mg/L)	T	0.5	0.5	0.5	0.5	0.45	0.45	0.5	0.5	0.55	0.55	0.6	0.45	0.45
MAR	Chlorine Dosage (mg/L)	R	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.3	1.8	1.6	1.5	1.6
		T	1.3	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.0	1.3	1.2	1.2	1.2
	Residual Chlorine Free	R	0.45	0.5	0.45	0.4	0.45	0.45	0.45	0.45	0.4	0.5	0.5	0.5	0.5
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
APR	Chlorine Dosage (mg/L)	R	2.1	2.2	1.4	1.9	1.8	2.2	2.4	2.1	2.4	2.1	2.1	2.2	2.5
		T	1.0	1.0	0.7	0.9	0.8	1.0	1.1	1.0	1.1	1.0	1.0	1.0	1.2
	Residual Chlorine Free	R	0.5	0.55	0.4	0.45	0.6	0.5	0.5	0.5	0.4	0.4	0.45	0.4	0.5
	(mg/L)	T	0.5	0.5	0.5	0.45	0.5	0.5	0.5	0.5	0.5	0.45	0.5	0.45	0.55
MAY	Chlorine Dosage (mg/L)	R	3.0	2.9	3.7	3.4	3.4	3.3	3.4	4.9	3.2	3.4	3.1	3.0	2.6
		T	1.4	1.4	1.8	1.6	1.6	1.5	1.6	2.3	1.5	1.6	1.5	1.4	1.2
	Residual Chlorine Free	R	0.9	1.0	1.0	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.7
	(mg/L)	T	0.9	0.9	0.9	1.0	0.9	1.0	1.0	0.85	0.9	0.8	0.9	1.0	0.8
JUN	Chlorine Dosage (mg/L)	R	5.2	4.4	3.6	3.4	2.5	2.7	2.5	3.5	2.5	2.5	3.3	2.7	3.6
		T	2.4	2.1	1.7	1.6	1.9	1.3	1.2	1.7	1.2	1.2	1.5	1.3	1.7
	Residual Chlorine Free	R	0.5	0.55	0.65	0.65	0.6	0.45	0.4	0.5	0.5	0.5	0.5	0.55	0.6
	(mg/L)	T	0.6	0.6	0.65	0.6	0.6	0.5	0.55	0.55	0.5	0.5	0.5	0.5	0.65
JUL	Chlorine Dosage (mg/L)	R	2.4	3.4	3.0	3.6	2.9	2.4	1.8	2.3	1.6	2.1	2.1	2.4	2.4
		T	1.4	2.0	1.8	2.1	1.7	1.5	1.1	1.4	1.0	1.3	1.3	1.4	1.4
	Residual Chlorine Free	R	0.45	0.5	0.6	0.6	0.5	0.5	0.3	0.4	0.35	0.45	0.3	0.2	0.3
	(mg/L)	T	0.55	0.6	0.6	0.7	0.55	0.5	0.55	0.5	0.5	0.5	0.4	0.45	0.55
AUG	Chlorine Dosage (mg/L)	R	2.5	3.4	2.9	2.8	2.8	2.6	1.9	2.4	2.4	2.6	2.6	3.1	3.1
		T	1.5	2.0	1.7	1.6	1.6	1.6	1.1	1.6	1.4	1.5	1.5	1.8	1.8
	Residual Chlorine Free	R	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.3	0.4
	(mg/L)	T	0.4	0.5	0.55	0.6	0.5	0.5	0.5	0.6	0.5	0.45	0.4	0.5	0.5
SEP	Chlorine Dosage (mg/L)	R	3.1	3.2	2.7	3.7	2.9	3.2	3.1	2.9	2.7	2.9	2.1	2.7	2.3
		T	1.9	1.9	1.6	2.2	1.7	1.9	1.8	1.7	1.6	1.7	1.2	1.6	1.4
	Residual Chlorine Free	R	0.5	0.5	0.45	0.45	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.40	0.4
	(mg/L)	T	0.5	0.55	0.5	0.5	0.5	0.5	0.6	0.55	0.55	0.6	0.6	0.4	0.4
OCT	Chlorine Dosage (mg/L)	R	3.0	2.8	2.8	2.9	2.8	2.4	2.4	2.7	2.6	2.5	2.7	2.6	2.3
		T	1.4	1.3	1.3	1.4	1.3	1.1	1.1	1.3	1.2	1.2	1.2	1.2	1.1
	Residual Chlorine Free	R	0.4	0.4	0.4	0.35	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.45
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5	0.6	0.5	0.5
NOV	Chlorine Dosage (mg/L)	R	2.8	2.7	2.5	2.1	2.8	2.1	2.6	2.6	2.3	2.8	2.7	2.4	2.8
		T	1.3	1.3	1.2	1.0	1.3	1.0	1.2	1.2	1.1	1.3	1.3	1.1	1.3
	Residual Chlorine Free	R	0.6	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.55	0.5	0.5	0.6	0.6	0.5	0.5	0.5
DEC	Chlorine Dosage (mg/L)	R	2.3	2.4	2.7	2.0	2.2	2.6	2.2	2.2	1.9	2.0	2.3	2.3	1.7
		T	0.9	0.9	1.0	0.7	0.8	0.9	0.8	0.8	0.7	0.7	0.9	0.9	0.6
	Residual Chlorine Free	R	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.4	0.6	0.6	0.6	0.6
	(mg/L)	T	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.45	0.4	0.5	0.5	0.5

R = Pre-chlorination
T = Post-chlorination

Source: Plant records

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MAX	MIN	AVG
2.2 1.3 0.6 0.5	2.3 1.4 0.65 0.55	2.2 1.3 0.6 0.5	2.5 1.5 0.7 0.55	1.9 1.1 0.7 0.5	2.0 1.2 0.6 0.5	2.0 1.2 0.6 0.45	1.6 1.0 0.7 0.5	2.1 1.2 0.7 0.5	2.1 1.3 0.7 0.5	1.9 1.2 0.8 0.55	1.9 1.2 0.7 0.5	2.2 1.3 0.65 0.5	2.7 1.6 0.5 0.45	2.4 1.4 0.6 0.5	2.0 1.2 0.7 0.5	2.1 1.3 0.75 0.6	2.1 1.3 0.7 0.5	2.7 1.6 0.8 0.6	1.6 1.0 0.4 0.4	2.1 1.2 0.6 0.5
1.8 1.3 0.5 0.45	1.6 1.2 0.6 0.5	1.8 1.3 0.5 0.5	1.7 1.3 0.6 0.5	1.8 1.3 0.6 0.5	1.6 1.2 0.6 0.5	1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	1.3 1.0 0.5 0.5	1.9 1.4 — —	1.6 1.2 0.5 0.5	1.9 1.4 0.5 0.5	2.1 1.5 0.5 0.5	1.7 1.2 0.45 0.5	1.9 1.4 0.5 0.5	— — — —	— — — —	— — — —	2.3 1.7 0.8 0.6	1.2 0.9 0.5 0.5	1.7 1.3 0.6 0.5
1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	3.6 2.6 0.5 0.5	1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	1.9 1.4 0.5 0.5	2.0 1.5 0.5 0.5	2.3 1.7 0.5 0.5	1.9 1.4 0.6 0.55	2.1 1.5 0.6 0.55	1.9 1.4 0.6 0.5	2.4 1.8 0.6 0.55	2.0 1.4 0.6 0.55	2.1 1.5 0.6 0.6	2.1 1.5 0.55 0.55	2.1 1.5 0.55 0.55	3.6 2.6 0.6 0.6	1.3 1.0 0.4 0.5	1.9 1.4 0.5 0.5
2.5 1.2 0.4 0.45	2.7 1.3 0.4 0.6	2.2 1.0 0.4 0.8	3.5 1.6 1.0 0.95	4.0 1.9 1.0 0.95	4.0 1.9 0.9 0.9	3.7 1.7 0.9 0.85	4.0 1.9 0.9 0.85	4.0 1.9 — —	3.8 1.8 0.9 0.9	3.3 1.5 0.9 0.9	2.7 1.3 0.9 0.9	3.6 1.7 0.9 0.9	3.8 1.8 0.95 0.9	2.7 1.3 0.8 0.75	1.5 0.7 0.6 0.8	2.8 1.3 0.8 0.8	— — — —	4.0 1.9 1.0 1.0	1.4 0.7 0.4 0.5	2.6 1.2 0.6 0.7
2.7 1.3 0.7 0.8	3.5 1.7 0.7 0.8	3.2 1.5 0.7 0.95	3.9 1.9 0.8 1.0	2.3 1.1 0.8 0.9	2.0 1.0 0.8 0.9	3.6 1.7 0.8 0.9	3.0 1.4 0.7 0.9	3.5 1.6 0.75 0.9	3.4 1.6 0.8 0.85	2.9 1.4 0.75 0.9	3.1 1.5 0.7 0.9	2.7 1.3 0.4 0.7	3.0 1.4 0.4 0.8	3.3 1.5 0.4 0.8	2.8 1.3 0.3 0.7	2.9 1.4 0.3 0.75	2.9 1.4 0.5 0.8	4.9 2.3 1.0 1.0	2.0 1.0 0.3 0.7	3.1 1.5 0.7 0.9
2.7 1.3 0.6 0.55	3.2 1.5 0.5 0.5	3.5 1.7 0.5 0.45	3.3 1.6 0.6 0.6	3.1 1.5 0.7 0.7	3.6 1.7 0.45 0.55	2.6 1.2 0.5 0.5	2.8 1.3 0.5 0.5	2.9 1.4 0.55 0.6	2.7 1.3 0.6 0.5	3.4 1.6 0.5 0.5	2.6 1.2 0.5 0.5	3.0 1.4 0.6 0.6	2.8 1.3 0.6 0.55	3.1 1.5 0.5 0.5	2.7 1.3 0.6 0.55	2.4 1.1 0.45 0.5	— — — —	5.2 2.4 0.7 0.7	2.4 1.1 0.4 0.5	3.1 1.4 0.5 0.5
2.3 1.3 0.3 0.45	2.3 1.3 0.2 0.4	2.3 1.3 0.2 0.35	3.4 1.4 0.2 0.3	3.4 1.4 0.3 0.4	3.2 1.9 0.3 0.45	3.1 1.8 0.4 0.55	2.3 1.4 0.35 0.5	2.4 1.4 0.4 0.5	2.6 1.5 0.2 0.5	2.3 1.3 0.3 0.4	2.1 1.2 0.4 0.6	2.4 1.4 0.3 0.45	2.6 1.5 0.3 0.5	2.6 1.5 0.3 0.4	2.1 1.2 0.4 0.5	2.2 1.3 0.4 0.4	2.7 1.6 0.3 0.55	3.6 2.1 0.6 0.7	1.6 1.0 0.2 0.3	2.4 1.4 0.4 0.5
3.1 1.8 0.4 0.5	3.7 2.2 0.5 0.5	3.0 1.8 0.4 0.5	3.5 2.0 0.4 0.5	2.4 1.4 0.3 0.5	2.6 1.5 0.2 0.5	2.8 1.7 0.3 0.4	2.8 1.7 0.5 0.4	3.3 2.0 0.5 0.55	3.5 2.1 0.5 0.6	3.0 1.8 0.5 0.6	2.9 1.7 0.4 0.5	3.7 2.2 0.4 0.5	3.1 1.8 0.4 0.5	3.4 2.0 0.5 0.5	3.5 2.1 0.5 0.6	3.5 2.1 0.5 0.6	3.4 2.0 0.5 0.5	3.7 2.2 0.5 0.6	1.9 1.1 0.2 0.4	2.9 1.7 0.4 0.5
2.6 1.5 0.2 0.4	2.5 1.5 0.2 0.4	2.8 1.6 0.2 0.4	2.2 1.3 0.3 0.5	2.6 1.5 0.4 0.6	2.8 1.7 0.4 0.6	2.2 1.3 0.45 0.5	2.5 1.5 0.43 0.5	2.2 1.3 0.4 0.5	2.2 1.3 0.4 0.5	2.5 1.5 0.5 0.5	2.5 1.5 0.5 0.5	2.4 1.4 0.6 0.55	3.3 1.9 0.6 0.55	2.8 1.7 0.6 0.5	2.4 1.4 0.6 0.5	2.7 1.6 0.5 0.5	— — — —	3.7 2.2 0.6 0.6	2.1 1.2 0.2 0.4	2.7 1.6 0.5 0.5
1.4 0.7 0.35 0.45	1.5 0.7 0.5 0.45	1.3 0.6 0.45 0.5	2.6 1.2 0.3 0.4	2.8 1.3 0.3 0.5	2.8 1.3 0.35 0.5	3.1 1.4 0.5 0.55	2.6 1.2 0.5 0.5	3.1 1.5 0.45 0.45	3.2 1.5 0.45 0.5	3.0 1.4 0.6 0.6	3.7 1.7 0.4 0.5	3.3 1.6 0.5 0.5	2.6 1.2 0.6 0.6	2.7 1.3 0.5 0.5	3.1 1.4 0.5 0.5	2.5 1.2 0.6 0.5	3.0 1.4 0.6 0.5	3.7 1.7 0.6 0.6	1.3 0.6 0.3 0.4	2.7 1.3 0.5 0.5
2.1 1.0 0.4 0.5	2.5 1.2 0.4 0.5	2.2 1.1 0.5 0.5	3.0 1.4 0.5 0.5	2.3 1.1 0.5 0.5	1.6 0.8 0.3 0.5	2.0 0.9 0.3 0.5	2.2 1.0 0.3 0.5	2.1 1.0 0.3 0.5	2.2 1.1 0.3 0.5	2.2 1.0 0.3 0.5	2.1 1.0 0.35 0.6	2.4 1.1 0.6 0.5	2.5 1.2 0.5 0.5	2.5 1.2 0.5 0.5	2.0 1.0 0.6 0.5	2.4 1.1 0.6 0.55	— — — —	3.0 1.4 0.6 0.6	1.6 0.8 0.3 0.5	2.4 1.1 0.5 0.5
2.1 0.8 0.6 0.5	2.0 0.7 0.6 0.5	2.4 0.9 0.6 0.5	2.2 0.8 0.6 0.5	2.2 0.8 0.6 0.5	2.3 0.9 0.6 0.5	2.2 0.8 0.5 0.5	2.0 0.7 0.5 0.5	2.2 0.8 0.5 0.5	2.3 0.9 0.6 0.5	2.2 0.8 0.6 0.5	2.6 1.0 0.6 0.5	2.4 0.9 0.6 0.5	2.4 0.9 0.6 0.5	2.4 0.9 0.6 0.5	2.4 0.9 0.6 0.5	2.4 0.9 0.6 0.5	2.8 1.0 0.5 0.5	2.8 1.0 0.6 0.5	1.7 0.6 0.4 0.4	2.3 0.8 0.6 0.5

TIMMINS WATER TREATMENT PLANT

TABLE 4.0: WATER QUALITY - RAW AND TREATED WATER - TESTS BY MINISTRY OF THE ENVIRONMENT LABORATORY

GENERAL CHEMISTRY		1984												DWSP DETECTION LIMIT	DRINKING WATER OBJ/GUIDELINE
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Alkalinity (mg/L)	R	38.8	62.4	43.0	24.4	32.4	25.6	32.0	41.6	38.6	36.6	38.2		0.2 mg/L	
	T	33.2	39.2	40.4	18.6	19.2	21.2	31.4	36.4	30.6	33.0	34.8			
Ammonium Total (mg/L)	R	.1W	.1W	.1T	.1W	.1W	.05W	.05W	.05W	.10T	.05W	.05W		0.05 mg/L	
	T	.1W	.1W	.1W	.1W	.1W	.05W	.05W	.05W	.10T	.05W	.05W			
Chloride (mg/L)	R	.2T	2.4	2.6	1.6	2.6	3.8	2.8	1.0	1.6	2.6	1.8		0.2 mg/L	250 mg/L
	T	2.0	3.4	3.6	3.4	4.2	4.4	4.6	3.6	3.6	3.2	3.8			
Colour (TCU)	R	54.0	47.7	4.5	82.0	52.5	87.0	53.0	50.5	45.0	42.5	47.5		0.5 TCU	5 TCU
	T	5.6	2.6	2.5	7.0	10.5	11.0	9.0	5.5	3.5	7.5	5.0			
Conductivity (umho/cm)	R	100.	109.	111.	72.0	91.0	78.0	88.0	94.0	96.5	96.9	98.1		0.01 umho/cm	
	T	140.	154.	164.	115.	118.	133.	142.	153.	145.	151.	157.			
Hardness (mg/L)	R	50.6	54.4	54.4	32.4	35.7	37.3	43.2	40.5	46.1	44.8	47.0		0.5 mg/L	
	T	63.5	72.7	73.5	49.3	41.5	56.1	63.8	61.4	63.0	62.7	69.6			
Nitrate (mg/L)	R	.2	.2	.2	.2	.1T	.05W	.05W	.05W	.10T	.05W	.15		0.05 mg/L	10 mg/L as N
	T	.2	.2	.2	.2	.1T	.25	.05W	.05W	.10T	.05W	.10T			
Nitrite (mg/L)	R	.01T	.01T	.01	.01T	.01W	.01W	.01W	.01W	.01T	.01W	.01T		0.005 mg/L	1 mg/L as N
	T	.01T	.01T	.01W	.01W	.01W	.01W	.01W	.01W	.01T	.01W	.01W			
Nitrogen Total Kjeldahl (mg/L)	R	.5	.3T	1.0	.5	.30T	.60	.40	.40	.35	.40	.60		0.1 mg/L	
	T	.2T	.2T		.2T		.15W	.20T	.20T	.15T	.40	.70			
pH	R	7.73	7.50	5.50	7.44	7.40	7.14	7.46	7.82	7.75	7.46	7.38			
	T	7.48	7.36	6.69	6.88	6.69	6.78	7.61	7.60	7.38	7.27	7.43			
Turbidity (FTU)	R	1.0	2.50	2.40	4.30	1.34	19.6	2.80	1.70	2.70	1.70	1.90		0.01 FTU	1 FTU
	T	.42	.55	.40	1.03	1.47	1.26	.58	1.00	.41	.40	.98			
Iron (mg/L)	R	.16	.15	.21	1.02	.22	1.60	.26	.18	.86	.30	.19		0.002 mg/L	0.3 mg/L
	T	.04T	.03T	.06	.20	.08	.15	.07	.07	.08	.50	.05			

NOTE: T - This measurement is tentative - for information only.
W - "Zero" value reported is minimum measurable amount.
NSS - No suitable sample.

Source: MOE Laboratory, Toronto

TIMMINS WATER TREATMENT PLANT

TABLE 4.0: WATER QUALITY - RAW AND TREATED WATER - TESTS BY MINISTRY OF THE ENVIRONMENT LABORATORY

GENERAL CHEMISTRY		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ/GUIDELINE
Alkalinity (mg/L)	R	38.8	41.0	38.8	38.2	25.4	26.4	27.2	33.6	36.4	32.8	33.8	34.6	0.2 mg/L	
	T	22.2	38.6	38.0	41.0	27.2	17.6	25.2	23.8	30.2	35.8	35.6	35.4		
Ammonium Total (mg/L)	R	.05W	.05W	.05W	.05W	.05T	.05W	.05W	.05W	.05W	.05W	.05W	.05W	0.05 mg/L	
	T	.05W	.05W	.05W	.05W	.05T	.05W	.05W	.05W	.05W	.05W	.05W	.05W		
Chloride (mg/L)	R	1.6	2.0T	2.8T	3.2T	3.6T	2.8T	4.2	2.6T	2.2	2.2T	1.6T	1.8T	0.2 mg/L	250 mg/L
	T	3.2	2.0T	4.0T	3.6T	4.0	3.6T	5.2	3.6T	4.2	3.4T	3.2T	2.6T		
Colour (TCU)	R	51.5	51.5	46.0	46.5	53.5	50.0	53.0	44.0	45.5	46.0	54.5	42.5	0.5 TCU	5 TCU
	T	6.5	5.5	3.0	3.5	4.0	13.0	6.0	2.0	2.0	3.5	5.0	2.5		
Conductivity (umho/cm)	R	103.	103.	103.	111.	81.0	84.8	96.8	89.8	97.0	88.7	96.1	96.9	0.01 umho/cm	
	T	139.	171.	170.	175.	138.	109.	143.	154.	154.	145.	160.	163.		
Hardness (mg/L)	R	48.1	49.0	48.6	50.1	34.9	37.8	38.6	44.4	39.5	40.2	43.6	44.4	0.5 mg/L	
	T	58.2	74.3	73.1	73.6	58.0	46.9	57.5	66.3	64.4	64.4	69.3	70.2		
Nitrate (mg/L)	R	.15	.20	.15T	.25T	.10T	.10T	.05W	.05W	.05W	.05W	.05W	.10T	0.05 mg/L	10 mg/L as N
	T	.15	.20	.10T	.25T	.10T	.10T	.05W	.05W	.05W	.05W	.15T	.10T		
Nitrite (mg/L)	R	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01T	.01W	.01W	.01W	0.005 mg/L	1 mg/L as N
	T	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W	.01W		
Nitrogen Total Kjeldahl (mg/L)	R	.5	.40	.40T	.10W	.40T	.40T	.50T	.60T	.50T	.30T	.40T	.40T	0.1 mg/L	
	T	.25T	.30T	.20T	.05W	.10W	.30T	.20T	.20T	.20T	.05W	.20T	.20T		
pH	R	7.39	7.27	7.38	7.28	6.55	7.17	7.10	7.29	7.51	7.30	7.34	7.86		
	T	6.62	7.34	7.39	7.55	7.19	6.62	7.13	6.75	7.17	7.91	7.64	7.69		
Turbidity (FTU)	R	1.58	1.09	3.80	9.30	2.50	2.90	6.10	1.70	4.20	1.94	1.24	1.03	0.01 FTU	1 FTU
	T	1.70	1.42	5.00	.73T	.45T	1.80	4.80	.63T	.34T	.71T	.45T	.39T		
Iron (mg/L)	R	.17	.16	.30	.66	.26	.019	.160	.170	.310	.200	NSS	NSS	0.002 mg/L	0.3 mg/L
	T	.04	.06T	.27	.08	.03T	.047	.074	.033	.015	.016				

NOTE: T - This measurement is tentative - for information only.
W - "Zero" value reported is minimum measurable amount.
NSS - No suitable sample.

Source: MOE Laboratory, Toronto

TIMMINS WATER TREATMENT PLANT

TABLE 4.0: WATER QUALITY - RAW AND TREATED WATER - TESTS BY MINISTRY OF THE ENVIRONMENT LABORATORY

GENERAL CHEMISTRY		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ/GUIDELINE
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Alkalinity (mg/L)	R T	38.6 38.6	38.6 38.4	40.4 38.4	21.5 21.0	27.8 30.3	32.1 32.0	36.5 34.3			30.5 28.5	32.4 30.9		0.2 mg/L	
Ammonium Total (mg/L)	R T	.05W .05W	.05W .05W	.05T .05T	.05W .05T	.05W .05W	.05W .05W	.10T .15T			.05W .05W	.05T .05W		0.05 mg/L	
Chloride (mg/L)	R T	.2W 1.4T	3.0T 3.4T	2.75 3.55	3.30 4.55	4.05 5.70	4.40 5.60	3.65 5.55			4.30 5.15	3.00 4.00		0.2 mg/L	250 mg/L
Colour (TCU)	R T	42.5 1.5T	44.5 4.5	37.0 5.0	63.0 5.0	51.5 3.0	36.0 2.5	34.5 3.5			55.0 4.0	53.0 8.5		0.5 TCU	5 TCU
Conductivity (umho/cm)	R T	97.0 162.	102. 160.	105. 159.	68.6 119.	81.4 145.	90.5 152.	95.5 150.			88.0 140.	87.4 138.		0.01 umho/cm	
Hardness (mg/L)	R T	46.5 74.3	49.0 71.4	51.0 73.0	31.0 49.5	37.5 62.5	43.0 68.5	44.5 67.0			42.5 63.5	39.5 60.5		0.5 mg/L	
Nitrate (mg/L)	R T	.1T .1T	.05W .05W	.05W .10T	.15T .20T	.05W .05W	.05W .05W	.10T .10T			.05T .05T	.20T .20T		0.05 mg/L	10 mg/L as N
Nitrite (mg/L)	R T	.01W .01W	.01W .[illegible]W	.01T .01T	.01T .01T	.01T .01T	.01W .01W	.01T .01T			.01W .01W	.01T .01T		0.005 mg/L	1 mg/L as N
Nitrogen Total Kjeldahl (mg/L)	R T	.4T .2T	.1T .1W	.2T .2W	.2T .2T	.40 .2T	.2T .2W	.2T .2T			.4T .2T	.4T .2T		0.1 mg/L	
pH	R T	7.11 7.41	7.37 7.33	7.61 7.65	7.35 7.41	7.49 7.77	7.72 7.78	7.68 7.57			7.27 7.39	7.74 7.56			
Turbidity (FTU)	R T	1.46 .29T	.68T 1.1T	2.50 2.4	4.60 .48T	1.63 .30T	2.20 .20T	2.40 .19T			1.76 .24T	1.41 .60		0.01 FTU	1 FTU
Iron (mg/L)	R T	NSS	NSS	NSS	NSS	NSS	.120 .002	.140 .005			NSS	NSS		0.002 mg/L	0.3 mg/L

NOTE: T - This measurement is tentative - for information only.
W - "Zero" value reported is minimum measurable amount.
NSS - No suitable sample.

Source: MOE Laboratory, Toronto

TIMMINS WATER TREATMENT PLANT

TABLE 5.0: ALGAE COUNT

MONTH	COUNT				
January	Max. Min. Avg. No. Tests				
February	Max. Min. Avg. No. Tests				
March	Max. Min. Avg. No. Tests				
April	Max. Min. Avg. No. Tests				
May	Max. Min. Avg. No. Tests				
June	Max. Min. Avg. No. Tests				
July	Max. Min. Avg. No. Tests				
August	Max. Min. Avg. No. Tests				
September	Max. Min. Avg. No. Tests				
October	Max. Min. Avg. No. Tests				
November	Max. Min. Avg. No. Tests				
December	Max. Min. Avg. No. Tests				

NOTE: No data on particulate counting, suspended solids or algae counts is available.

TIMMINS WATER TREATMENT PLANT

TABLE 6.0: BACTERIOLOGICAL TESTING 1987

		TOTAL COLIFORM					FECAL COLIFORM					FECAL STREPTOCOCCUS			
MONTH	R/T	ABSENT	1-5	6-100	101-5000	5000	ABSENT	1-5	6-10	11-500	500	ABSENT	1	2-50	50
JAN	R														
	T														
FEB	R														
	T	30	--	--	--	--	30	--	--	--	--				
MAR	R														
	T	25	--	--	--	--	25	--	--	--	--				
APR	R														
	T	33	1	--	--	--	33	1	--	--	--				
MAY	R														
	T	30	--	--	--	--	30	--	--	--	--				
JUN	R														
	T	32	--	--	--	--	32	--	--	--	--				
JUL	R														
	T	31	--	1	--	--	31	--	--	1	--				
AUG	R														
	T	29	--	--	--	--	29	--	--	--	--				
SEP	R														
	T	31	--	--	--	--	31	--	--	--	--				
OCT	R														
	T	28	--	--	--	--	28	--	--	--	--				
NOV	R														
	T	32	--	--	--	--	32	--	--	--	--				
DEC	R														
	T	30	--	--	--	--	30	--	--	--	--				

NOTE: All results are for 100 mL samples. Tests carried out at MOE lab, Timmins. No analysis performed for Fecal Streptococcus.

R = Raw; T = Treated

Source: Public Health Laboratory, Timmins

TIMMINS WATER TREATMENT PLANT

TABLE 6.1: BACTERIOLOGICAL TESTING - 1984, 1985 AND 1986

	1984			1985			1986		
	1	2	3	1	2	3	1	2	3
JANUARY				0-0	0-0	0-0	0-0		
FEBRUARY				0-0	0-0	0-0	0-0		
MARCH				0-0	0-0	0-0	0-0		0-0
APRIL				0-0	0-0	0-0	0-0	0-0	0-0
MAY		0-0	0-0	0-0		0-0	0-0	0-0	0-0
JUNE	0-0	0-0	2-0	0-0	0-0	2-0		0-0	0-0
JULY	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0
AUGUST	0-0			0-0	0-0	0-0	0-0	0-0	0-0
SEPTEMBER	0-0	0-0	0-0	0-0	2-0	0-0	0-0		0-0
OCTOBER	0-0		0-0	0-0			0-0	0-0	0-0
NOVEMBER	0-0	0-0	0-0	0-0	2-0		0-0		0-0
DECEMBER		0-0	0-0	0-0			0-0	0-0	0-0

SAMPLING SITE:
1 - Golden Manor - Nursing Home
2 - Fairway - Trailer Camp
3 - Ruttan - Trailer Camp

First value denotes Total Coliform is 50 mL/sample
Second value denotes Fecal Coliform is 50 mL/sample

Source: Public Health Laboratory, Timmins

TIMMINS WATER TREATMENT PLANT

TABLE 7.0: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY INCLUDING ALUMINUM (TREATED WATER AT PLANT)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT
Period Jan-Feb 1984	Turbidity	Max. 3.1 FTU	1.0 FTU
Period July-Dec 1984	Turbidity	Max. 8.6 FTU	1.0 FTU
Period Jan-Sept 1985	Turbidity	Max. 4.4 FTU	1.0 FTU
Period Nov 1985	Turbidity	Max. 3.5 FTU	1.0 FTU
Period Jan-Apr 1986	Turbidity	Max. 3.5 FTU	1.0 FTU
Period Oct-Nov 1986	Turbidity	Max. 1.3 FTU	1.0 FTU
Period Jul 1985-Feb 1986	Residual alum	Max. 1.5 mg/L	0.1 mg/L
Period May 1986-July 1986	Residual alum	Max. .28 mg/L	0.1 mg/L
Period Sept 1986-Oct 1986	Residual alum	Max. .50 mg/L	0.1 mg/L

NOTE: Turbidity values influenced by lime particles.
Residual alum concentrations have been decreasing since measuring commenced.

Source: Plant records

TIMMINS WATER TREATMENT PLANT

TABLE 7.1: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY (DISTRIBUTION SYSTEM)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT

NOTE: No data from the distribution system are available.

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive an information package from the MOE. Review the information provided and meet with the MOE staff, if required, to discuss the project.

2. Document the quality and quantity of raw and treated waters.

3. Define the present treatment processes and operating procedures. Prepare a progress report on Works Tasks 1-3 for the Project Committee.

4. Assess the methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant.

5. Assess current disinfection practices and possible improvement methods.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal.

7. Prepare a draft report for the project committee's review.

8. Prepare the final report.

1. RECEIVE AN INFORMATION PACKAGE FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF, IF REQUIRED, TO DISCUSS THE PROJECT.

Elements of **Work**

(a) Receive an information package from the MOE concerning the plant and the study. This package includes a general terms of reference, a general table of contents for organizing the study in a manner consistent with other plant reports, the WPOS reporting tables and a copy of Ontario Drinking Water Objectives.

(b) Review the information and prepare for a meeting to initiate the work on the project, including preparation of a schedule of manpower and staff committments.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule. If a consultant is carrying out more that one study it may not be necessary to meet with the MOE at the start of each study.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS.

Elements of Work

(a) Prepare a monthly summary of maximum, minimum, and average flows for the last three consecutive years (Table 1.0). Address any discrepancies which exist between raw and treated flow rates.

(b) Based on the above, briefly review and tabulate for the last three years, the monthly maximum, minimum, and average per capita flow for the total population served by the plant (Table 1.1). Compare the plant data with typical per capita flows for the local region. Indicate major consumers who may influence the figures.

(c) Document the methods of measuring the raw and treated water flow rates.

(d) Summarize, for the last three consecutive years, where available, the raw and treated water; turbidity, colour, residual aluminum/iron, pH, temperature and treatment chemical dosages (other than disinfection and fluoridation). The summary should indicate the monthly daily average and maximum and minimum day (Table 2.0).

For the same three year period, tabulate also the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with particulate removal occurred (Tables 2). Document enough data to define and evaluate those problems.

Record other data, such as particulate counting, suspended solids, and algae counting (Table 5.0) which could reflect on particulate removal efficiency.

Document the source and methods used in determining all information.

A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(e) Summarize for the last three consecutive years, where available, the disinfectant demand, dosages (including all disinfection related chemicals and residuals) for all application points as well as fluoridation dosage and residual. The summary should indicate the monthly daily average and maximum and minimum day (Table 3.0).

For the same three year period, tabulate (Tables 3) the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with chlorine residuals and/or positive bacterial tests identified in Table 6. Document enough data to define and evaluate those problems.

Document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(f) Prepare a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information (Table 4). Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information.

Document the source and methods used in determining all water quality information and establish the validity of the data, comparing plant and outside laboratory data.

(g) Tabulate, for the last three consecutive years, the raw and treated water bacterial test information at the plant (Table 6).

Document the source and methods used for all data provided.

(h) Document the water sampling systems (source, pump, line-material and size, vertical rise velocity sampling location) used in the plant (similar to DWSP Questionnaire in Appendix A).

(i) Prepare a summary of inplant testing including Test, Sampling Point, Testing Frequency, Reporting Frequency, Testing Instrumentation including calibration.

(j) Identify other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. PREPARE A PROGRESS REPORT ON WORK TASKS 1-3 (8 COPIES), FOR THE PROJECT COMMITTEE.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings of a reduced size, to document the general site layout and the interrelationship of major plant components. If available, include a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of all major plant components including chemical systems and indicating design parameters. Appendix B is an example of the required standard schematic.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems. The record should include approximately 30-40 coloured (9 cm x 12 cm) (or 10 cm x 15 cm) prints, suitably labelled. The progress and draft reports may include photocopies in lieu of the prints.

(d) Tabulate the design parameters for all the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire (Appendix A) and must be confirmed and verified by field observations. The design parameters should be evaluated at design, rated and actual operational flows.

(e) Prepare a summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document all reported and other apparent problems in plant operations and/or in the distribution system related to water quality. In addition list the health related parameters which exceed the Ontario Drinking Water Objectives (Table 7).

(g) Submit 8 copies of the progress report to the Prime Consultant for distribution to the Project Committee.

4. ASSESS THE METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT.

Elements of Work

(a) Assess the validity and implication of all information relating to particulate removal provided in Work Tasks 1 and 2 with emphasis on method, metering and sampling, etc.

(b) Using information provided in Work Tasks 1, 2 and 3 evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 F.t.u. It should, however, be recognized that it is desirable to strive for an operational level which is as low as is achievable.

(c) Conduct an evaluation of possible optimum performance alternatives. Include jar testing using established industry practice.

(d) Evaluate the feasibility of optimum removal using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(e) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

5. ASSESS CURRENT DISINFECTION PRACTICES AND POSSIBLE IMPROVEMENT METHODS.

Elements of Work

(a) Assess the validity and implication of all information relating to disinfection provided in Work Tasks 1, 2 and 3 with emphasis on method, metering and sampling etc.

(b) Using the information provided in Work Tasks 1, 2 and 3 evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives.

(c) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(d) Evaluate the feasibility of the various alternatives using the existing plant capital works.

(e) Assess the relative merits of the alternatives. Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL.

Elements of Work

(a) Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost and possible schedule for implementation for each of the proposed modifications.

It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

(b) Incorporate (a) above in the draft report.

7. PREPARE A DRAFT REPORT FOR THE PROJECT COMMITTEE'S REVIEW. (8 COPIES).

Elements of Work

(a) The report must include all information for Work Tasks 1-6.

The information must be organized and presented in a logical and co-ordinated fashion. A general table of contents (Appendix C) is provided for organizing the material in a manner consistent with other plant reports.

Submit the draft report for review by the Project Committee.

(b) Meet with the Project Committee on site at least one week after submission of the report.

(c) Prepare a separate letter report containing recommendation(s) concerning the need for additional field testing to cover quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. PREPARE THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implementations of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit 25 copies of the final reports (including the colour photographs) to the MOE for distribution.

WATER PLANT OPTIMIZATION STUDY

TIMMINS
WATER TREATMENT PLANT

TREATABILITY STUDY

Project No. 7-2043

March 1988

Heather Broomer
Drinking Water Section
Water Resources Branch

WATER PLANT OPTIMIZATION STUDY

TIMMINS - JAR TEST REPORT

The raw water source (Mattagami River) for the Timmins Water Treatment Plant was sampled on August 17, 1987. The plant treatment process is illustrated in Figure 1. A 60 litre raw water sample was requested and received for the jar test evaluation. Raw and treated water samples from the plant were submitted to the MOE Laboratory Services Branch for analysis (listed in Table 1) on August 28, 1987. A raw water sample (from the 60 L aliquot) was also submitted for chemical analysis on August 17, 1987 along with the samples generated by the final runs.

Jar Test Conditions

All jar testing was performed at 22°C, which was the raw water temperature at the time of sampling. Sample aliquots for preliminary work and final runs were 500 ml and 3500 ml, respectively. All samples were subjected to the same conditions. All final run samples were chlorinated and allowed a contact time of 30 minutes after the addition of chlorine. Chemical addition was followed by one minute of flash mixing at 100+ rpm, flocculation for 25 minutes at 25 rpm and sedimentation for 30 minutes. Preliminary runs were filtered through Whatman 541 filter paper. Final runs were filtered through a sand and anthracite bed (glass column) at a rate of 90 mL/min which is equivalent to a 9m/hr filtration rate.

Preliminary Jar Tests

Initial jar tests were performed using alum, the coagulant currently in use in the plant. Alum dosages ranged from 25 mg/L to 50 mg/L. All jars produced poor quality, small floc that increased in quantity proportional to the alum dosage. A supernatant turbidity of 0.44 FTU, a filtered turbidity of 0.30 FTU and a filtered water aluminum residual of 0.040 mg/L indicated that 45 mg/L alum was the optimum dosage.

In order to choose the most suitable polyelectrolyte for use in conjunction with alum, eleven different polymers were tried at a dosage of 0.5 mg/L with the optimum alum dosage of 45 mg/L. Magnifloc A100 (anionic) produced medium-sized, compact, good quality floc. Percol LT25 (anionic) produced floc that was slightly larger, more compact and uniform, and generally better quality floc than Magnifloc A100. Of the eleven polymers tried, Percol LT25 produced floc with the best physical characteristics although Magnifloc A100 would be an excellent second choice.

Percol LT25 was then compared to the polymer Alchem IU50 (nonionic) which is presently in use in the plant. Percol LT25 produced floc that was slightly larger. Floc produced by Alchem IU50 at a dosage of 0.5 mg/L was slightly sticky. These two polymers were also compared at lower dosages ranging from 0.15 mg/L to 0.4 mg/L; Percol LT25 produced floc with superior physical characteristics.

As an alternate primary coagulant, polyaluminum chloride (PAC) was optimized using dosages from 12.5 mg/L to 30 mg/L. The jars containing 12.5 mg/L to 17.5 mg/L PAC produced a small quantity of barely visible pinfloc. Dosages from 20 mg/L to 30 mg/L PAC produced small, light, compact floc that increased in quantity proportional to the PAC dosage. A supernatant turbidity of 0.23 FTU, a filtered turbidity of 0.17 FTU and a filtered water aluminum residual of less than 0.01 mg/L indicated that 30 mg/L PAC was the optimum dosage for this run.

In order to choose the most suitable polyelectrolyte for use in conjunction with PAC, twelve different polymers were tried at a 0.5 mg/L dosage with the optimum PAC dosage of 30 mg/L. Magnifloc A100 produced average quality floc that was medium-sized and compact. Percol LT25 produced good quality floc that was medium-sized, compact and uniform. Of the twelve polymers tried, Percol LT25 produced floc with the best physical characteristics. Magnifloc A100 would make a very good second choice.

Activated silica was tried as an alternate coagulant aid in conjunction with alum. Alum dosages ranged from 40 mg/L to 45 mg/L with activated silica dosages ranging from 4.0 mg/L to 4.75 mg/L. All jars produced a large quantity of light, feathery floc that settled very well. All filtered water aluminum residuals were higher than the ODWO recommended guideline value of 0.1 mg/L. Therefore, two additional jars were tried using slightly different alum and activated silica dosage combinations. A supernatant turbidity of 0.38 FTU, a filtered turbidity of 0.10 FTU and a filtered water aluminum residual of 0.02 mg/L indicated that 45 mg/L alum with 4.0 mg/L activated silica was the optimum dosage.

PAC was also tried in conjunction with activated silica. PAC dosages ranged from 25 mg/L to 30 mg/L and activated silica dosages ranged from 1.5 mg/L to 3.0 mg/L. All jars produced a large quantity of light, fluffy, small floc that settled well. A supernatant turbidity of 0.14 FTU, a filtered turbidity of 0.10 FTU and a filtered water aluminum residual of 0.04 mg/L indicated that 30 mg/L PAC with 2.0 mg/L activated silica was the optimum dosage.

Final Runs

Based on this preliminary work, five final runs were selected. The Laboratory Services Branch analytical results are indicated in Table 1. Drinking Water Section observations and on-line jar test results are recorded in Table 2. The analytical results indicated a raw water source of fair quality. Turbidity (1.86 FTU), colour (31.5 TCU) and DOC (8.4 mg/L) were the only critical parameters analysed that would require reduction to produce a treated drinking water supply in compliance with the Ontario Drinking Water Objectives (ODWO).

On August 17, 1987 the plant treatment process consisted of the addition of 2.5 mg/L Cl_2, 45 mg/L alum and 0.15 mg/L Alchem IU50. This treatment was duplicated in jar tests and is represented by 17-T-1. Analytical results were similar for both the plant treated (17-T-T) and lab treated (17-T-1) samples. The results of all critical parameters analysed met the ODWO requirements. Zinc (0.410 mg/L) in the plant treated sample is higher than the lab treated (0.007 mg/L). This can be attributed to the zinc polyphosphate addition in the clearwell for corrosion control.

This was not added during the lab treatment since lime and zinc polyphosphate are added after particulate removal. The 17-T-T final aluminum residual was comparable to the aluminum level in the raw water sample and higher than the resultant aluminum of 17-T-1 (0.057 mg/L). Alkalinity was much higher in 17-T-T due to the addition of lime at the plant.

Treatment 17-T-2 (2.5 mg/L Cl_2 + 45 mg/L alum + 0.4 mg/L Percol LT25) is similar to 17-T-1 but used a polymer that had produced floc with better physical characteristics in preliminary work. Analytical results were comparable. However, the final aluminum residual (0.170 mg/L) exceeded the ODWO recommended guideline value of 0.10 mg/L. Therefore, although preliminary tests predicted better results, this treatment at these dosages was not optimized and is unsuitable for this raw water sample. Colour was below the Maximum Desirable Concentration (MDC) of 5.0 TLU but removal was not quite as efficient as 17-T-1.

PAC is used as an alternate primary coagulant in treatment 17-T-3 (2.5 mg/L Cl_2 + 30 mg/L PAC + 0.5 mg/L Percol LT25). Analytical results were similar to treatment 17-T-2. Colour is equivalent to the MDC of 5.0 TCU allowing very little margin for day to day variations in the treatment process. Alkalinity is higher as is expected when using PAC rather than alum as the primary coagulant. The final aluminum residual (0.15 mg/L) exceeds the ODWO recommended guideline value of 0.1 mg/L and renders this treatment unsuitable for this raw water sample at these dosages.

Treatment 17-T-4 (2.5 mg/L Cl_2 + 45 mg/L alum + 4.0 mg/L activated silica) is similar to 17-T-2 but replaces the polyelectrolyte with activated silica. All the results of critical parameters analyzed met the ODWO requirements. The final aluminum residual was very low, indicative of an efficient treatment process.

Treatment 17-T-5 (2.5 mg/L Cl_2 + 30 mg/L PAC + 2.0 mg/L activated silica) is similar to 17-T-4 but uses PAC as the primary coagulant. All the results of critical parameters analyzed met the ODWO requirements. Colour and aluminum results were higher than 17-T-4 but superior to results displayed by the other four treatments.

Marble tests to measure the stability of the treated water were performed on all final run samples. The results of these tests are indicated in Table 3. All treatments produced corrosive water and would require post pH adjustment to lower the aggressiveness of the finished water.

Of the five treatments represented by final runs, results indicate 17-T-4 and 17-T-5 are both suitable treatments for this raw water source. The present plant process 17-T-1 also produced a finished water that was acceptable. Although trihalomethane levels in both lab treated and plant treated samples were within the ODWO requirements, values were comparatively high. Therefore, subsequent treatability studies should investigate lowering the production of trihalomethanes.

TABLE 1

LABORATORY SERVICES BRANCH ANALYSIS ANALYTICAL RESULTS

PLANT	SAMPLE	DATE	DESCRIPTION OF TREATMENT
Timmins	17-T-R	17/8/87	Raw Water (W.T.P.)
	17-T-R	28/8/87	Raw Water (60 L. Sample)
	17-T-T	17/8/87	Treated Water (Plant)
	17-T-1	28/8/87	2.5 mg/L Cl_2 + 45 mg/L Alum + 0.15 mg/L Alchem 1U50
	17-T-2	28/8/87	2.5 mg/L Cl_2 + 45 mg/L Alum + 0.4 mg/L Percol LT25
	17-T-3	28/8/87	2.5 mg/L Cl_2 + 30 mg/L PAC + 0.5 mg/L Percol LT25
	17-T-4	28/8/87	2.5 mg/L Cl_2 + 45 mg/L Alum + 4.0 mg/L Activated Silica
	17-T-5	28/8/87	2.5 mg/L Cl_2 + 30 mg/L PAC + 2.0 mg/L Activated Silica

	RAW WATER		WTP	LAB TREATED - FINAL RUNS					
	17-T-R	17-T-R	17-T-T	17-T-1	17-T-2	17-T-3	17-T-4	17-T-5	UNITS
METALS									
IRON	.170		.007	<.003	<.003	<.003	<.003	<.003	mg/L
MANGANESE	.025		.006	.009	.009	.011	.011	.011	mg/L
ALUMINUM	.086		.083	.057	.170	.150	.009	.020	mg/L
ARSENIC	<.001		<.001	<.001	<.001	<.001	<.001	<.001	mg/L
COPPER	.073		.015	.026	.032	.024	.024	.021	mg/L
LEAD	<.003		<.003	.004	.017	<.003	<.003	<.003	mg/L
ZINC	<.002		.041	.007	.008	<.002	.006	<.002	mg/L
GENERAL CHEMISTRY									
CONDUCTIVITY	106.8	107.1	169.0	126.9	126.2	125.0	135.0	128.2	umho/cm
HARDNESS	56	58	80	57	57	58	56	56	mg/L
CALCIUM	16.0	16.4	25.4	16.4	16.4	16.2	16.0	15.8	mg/L
MAGNESIUM	4.0	4.10	4.1	4.0	4.0	4.1	4.0	4.1	mg/L
SODIUM	1.4	1.2	1.6	3.4	3.2	3.4	4.8	4.0	mg/L
POTASSIUM	.35	.35	.40	.35	.40	.35	.35	.35	mg/L
ALKALINITY	41.6	40.5	34.5	20.6	20.8	29.1	21.7	29.0	mg/L
pH	7.53	7.68	7.42	7.37	7.38	7.55	7.46	7.56	---
CHLORIDE	4.2	4.1	4.6	6.1	6.2	14.7	6.2	15.0	mg/L
SULPHATE	5.7	5.8	37.2	27.6	27.5	8.0	29.4	8.8	mg/L
TURBIDITY	1.86	1.79	.17	.12	.24	.21	.17	.07	FTU
TRUE COLOUR	31.5	30.0	3.5	3.5	4.0	5.0	3.5	4.5	TCU
TOTAL PHOSPHORUS	.01<T	.01<T	.05	<.01<W	<.01<W	.01<T	<.01<W	.02<T	mg/L
TOTAL KJELDAHL	.40	.40	.10<T	.20<T	.20<T	.30	.70	.80	mg/L
AMMONIUM	.05<T	.05<T	<.05<W	<.05<T	<.05<W	.05<T	.05<T	.05<T	mg/L
NITRATES	.50	.10<T	.35	.45	.15<T	.35	.35	.40	mg/L
NITRITE	<.005<W	<.005<W	.03	<.005<W	<.005<W	<.005<W	<.005<W	<.005<W	mg/L
DOC	8.4	8.3	3.0	3.8	3.9	4.3	4.0	4.4	mg/L
PRIORITY ORGANICS									
CHLOROFORM	0<W		206	182	166	201	169	172	ug/L
BROMODICHLOROMETHANE	0<W		11	9	2	9	2	7	ug/L
CHLORODIBROMOMETHANE	0<W		0<W	0<W	0<W	0<W	0<W	0<W	ug/L
TOTAL TRIHALOMETHANES	0<W		217	191	168	210	171	179	ug/L

<T - Value recorded is below the usual reporting limit and is for information only (tentative).

<W - Less than the lowest detectable concentration.

REV. 14/04/89

TABLE 2

DRINKING WATER SECTION JAR TEST RESULTS

FINAL RUNS PLANT: TIMMINS DATE: AUG. 12/87

JAR # 17-T-1 Representative of plant

TREATMENT:	CHLORINE RESIDUAL (mg/L)
2.5 mg/L Cl_2 + 45 mg/L alum + 0.15 mg/L Alchem IU50	BEFORE FILTRATION - FREE 0.82 - TOTAL 1.05 AFTER FILTRATION - FREE 0.12 - TOTAL 0.31
COMMENTS AND DESCRIPTION: Floc produced was small, light and fluffy. There was some still floating after sedimentation.	pH 6.40 ALKALINITY 22 mg/L ALUMINUM 0.01 mg/L TURBIDITY 0.17 FTU

JAR # 17-T-2 Optimum alum dosage with best polymer.

TREATMENT:	CHLORINE RESIDUAL (mg/L)
2.5 mg/L Cl_2 + 45 mg/L alum + 0.4 mg/L Percol LT25	BEFORE FILTRATION - FREE 0.88 - TOTAL 1.08 AFTER FILTRATION - FREE 0.18 - TOTAL 0.30
COMMENTS AND DESCRIPTION: Floc produced was light and fluffy, larger and more compact than treatment 17-T-1.	pH 6.80 ALKALINITY 22 mg/L ALUMINUM 0.055 mg/L TURBIDITY 0.45 FTU

JAR #17-T-3 Optimum PAC dosage with best polymer.

TREATMENT:	CHLORINE RESIDUAL (mg/L)
2.5 mg/L Cl_2 + 30 mg/L PAC + 0.5 mg/L Percol LT25	BEFORE FILTRATION - FREE 0.81 - TOTAL 0.99 AFTER FILTRATION - FREE 0.12 - TOTAL 0.30
COMMENTS AND DESCRIPTION: The floc produced was medium-sized and fluffy, very similar to treatment 17-T-2.	pH 7.05 ALKALINITY 29 mg/L ALUMINUM <.01 mg/L TURBIDITY 0.35 FTU

JAR #17-T-4 Optimum alum dosage with activated silica.

TREATMENT:	CHLORINE RESIDUAL (mg/L)
2.5 mg/L Cl_2 + 45 mg/L alum + 4.0 mg/L activated silica	BEFORE FILTRATION - FREE 0.88 - TOTAL 1.09 AFTER FILTRATION - FREE 0.09 - TOTAL 0.90
COMMENTS AND DESCRIPTION: Floc produced was small, light, fluffy and loose.	pH 7.10 ALKALINITY 23 mg/L ALUMINUM <.01 mg/L TURBIDITY 0.32 FTU

JAR #17-T-5 Optimum PAC dosage with activated silica.

TREATMENT:	CHLORINE RESIDUAL (mg/L)
2.5 mg/L Cl_2 + 30 mg/L PAC + 2.0 mg/L activated silica	BEFORE FILTRATION - FREE 0.80 - TOTAL 1.05 AFTER FILTRATION - FREE 0.04 - TOTAL 0.82
COMMENTS AND DESCRIPTION: Floc produced was small, light, fluffy and loose.	pH 6.95 ALKALINITY 31 mg/L ALUMINUM 0.01 mg/L TURBIDITY 0.25 FTU

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TABLE 3
MARBLE TEST RESULTS
PLANT: TIMMINS

SAMPLE	pH		NET RESULT
	PRE $CaCO_3$ ADDITION	POST $CaCO_3$ ADDITION	
17-T-1	7.20	7.40	+0.20
17-T-2	7.00	7.55	+0.55
17-T-3	7.10	7.50	+0.40
17-T-4	7.30	7.60	+0.30
17-T-5	7.50	7.70	+0.20

"Marble Test"

This simple test readily determines the correct pH value for treatment to prevent corrosion in a given water.

Procedure:

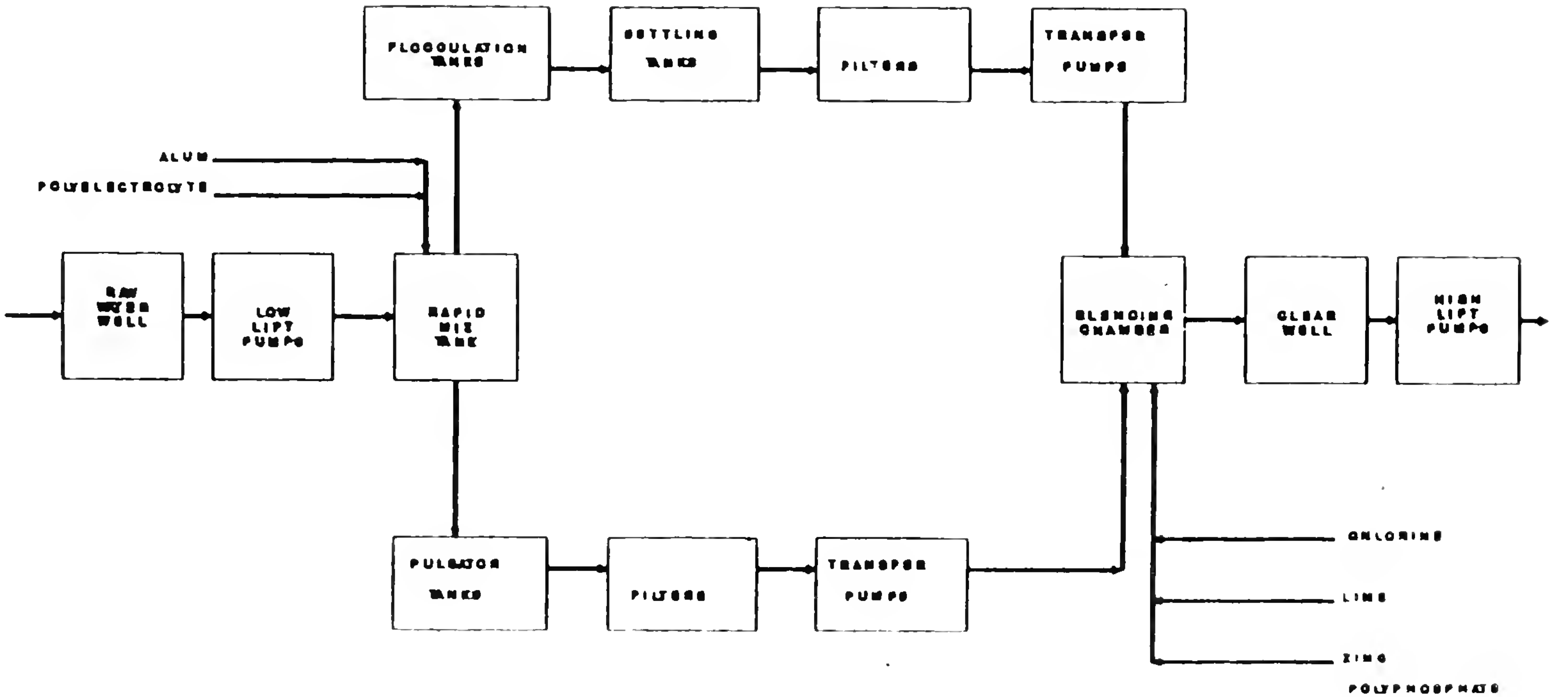
(1) "Divide the sample of water to be tested into two parts. Determine the total alkalinity using Bromo Cresol Green Methyl Red indicator and also the pH value, on one sample, recording the result obtained. To the other sample add considerable excess of powdered solid calcium carbonate, using a stoppered pyrex flask, shake for a few minutes, allow to stand overnight, filter and determine the alkalinity and pH as before."

If the alkalinity of pH of the second sample are higher than those of the first, the water is corrosive, in that it dissolves calcium carbonate. If the alkalinity and pH are the same for both samples, the water is stable. If the alkalinity and pH of the second sample are lower than those of the first, the water will precipitate calcium carbonate in pipe lines.

[1]Hopkins, Edward Scott, Water Purification Control, Fourth Edition, Pg. 214.

HB/eal
20025-01C/DWS/88-1

Figure I
Timmins Water Treatment Plant Process



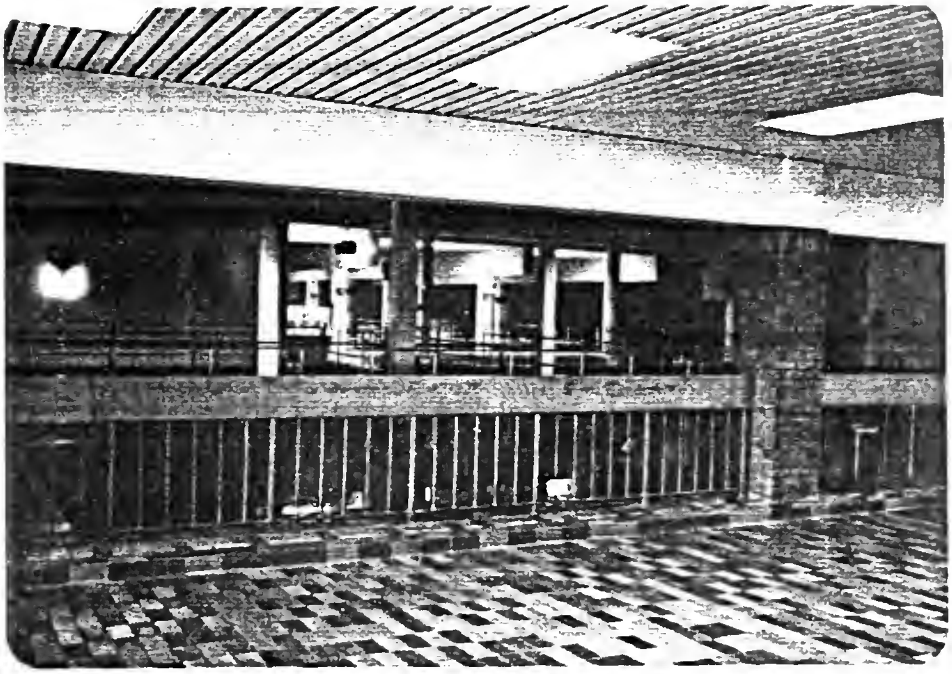


PHOTO NO. 1 - MAIN FLOOR
NEPTUNE MICROFLOC FILTERS
1985 ADDITION IN BACKGROUND

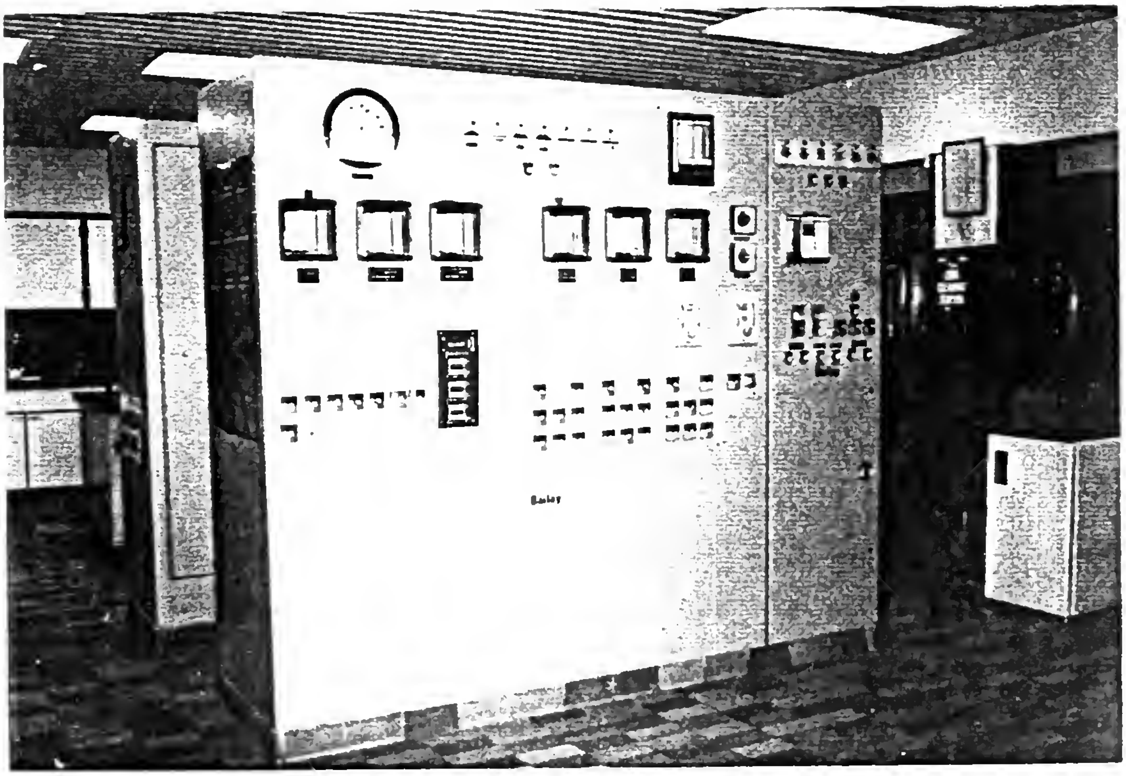


PHOTO NO. 2 - CONTROL ROOM
LABORATORY AND PLANT OPERATING PANEL

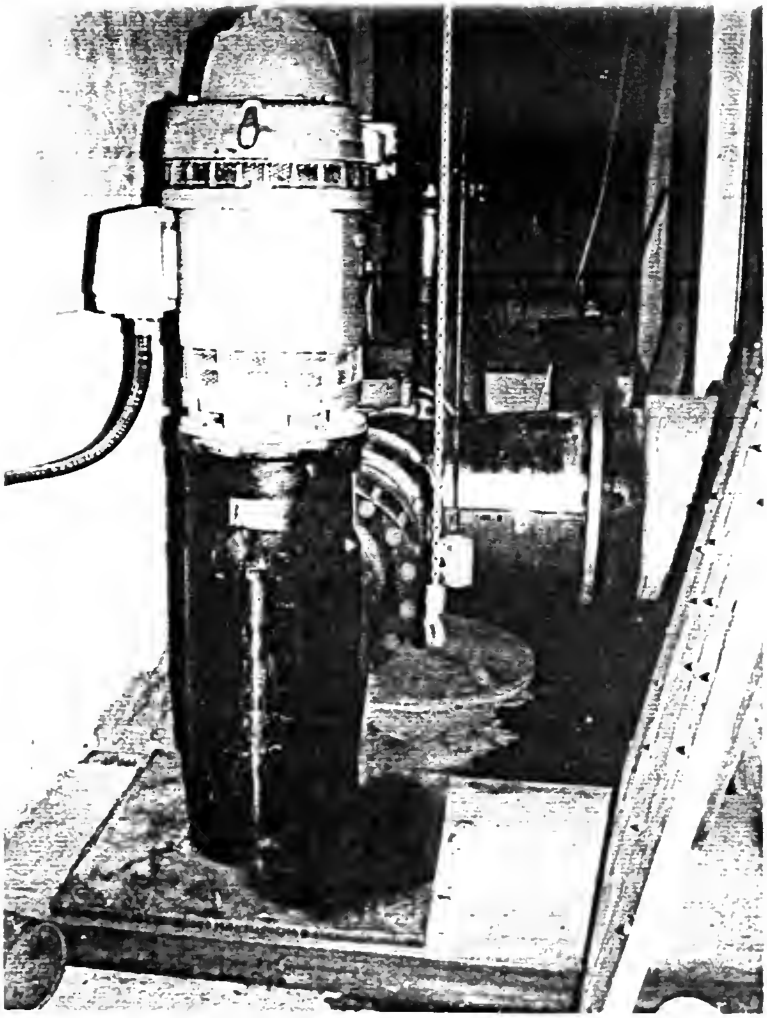


PHOTO NO. 3

LOW LIFT PUMPS
NO. 3 AND NO. 4

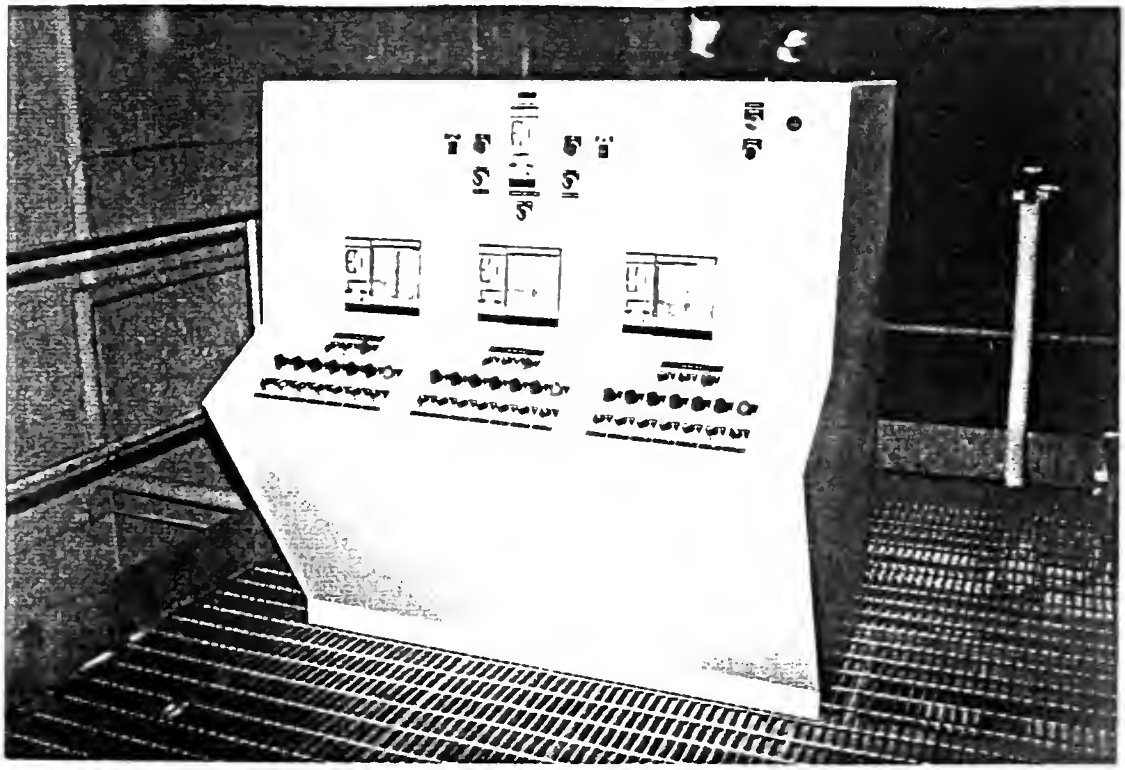


PHOTO NO. 4 - DEGREMONT FILTER CONTROL PANEL

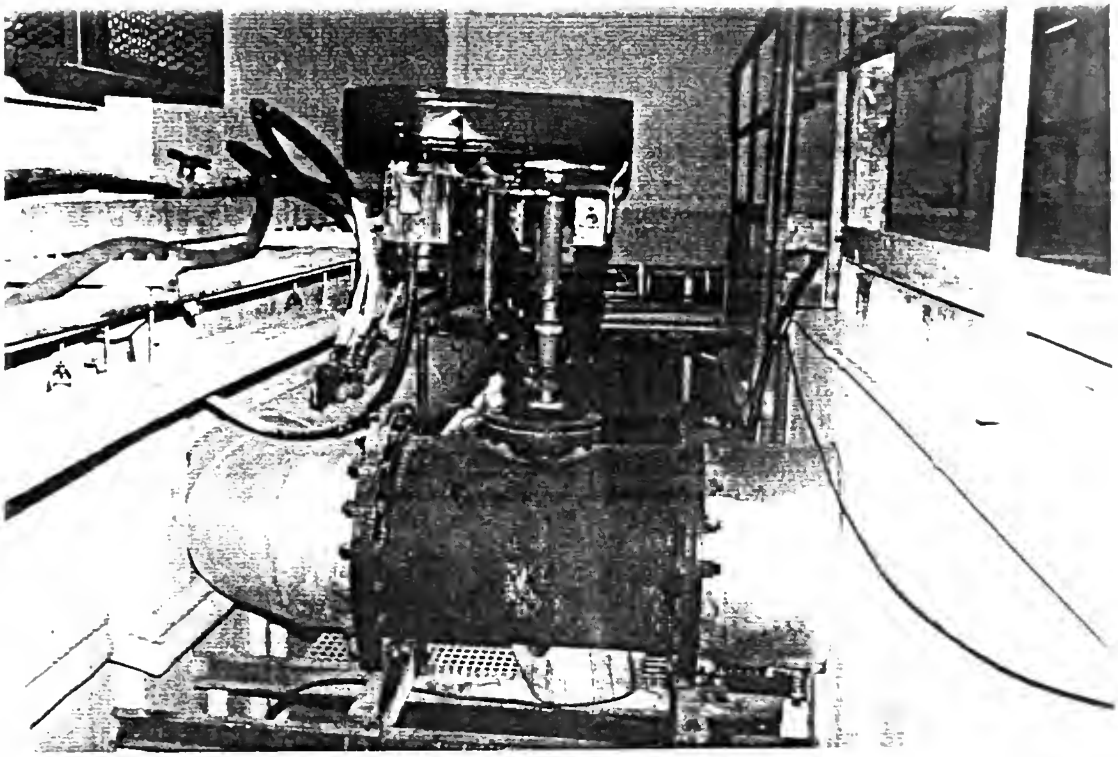


PHOTO NO. 5 - 1972 IN-LINE MIXER

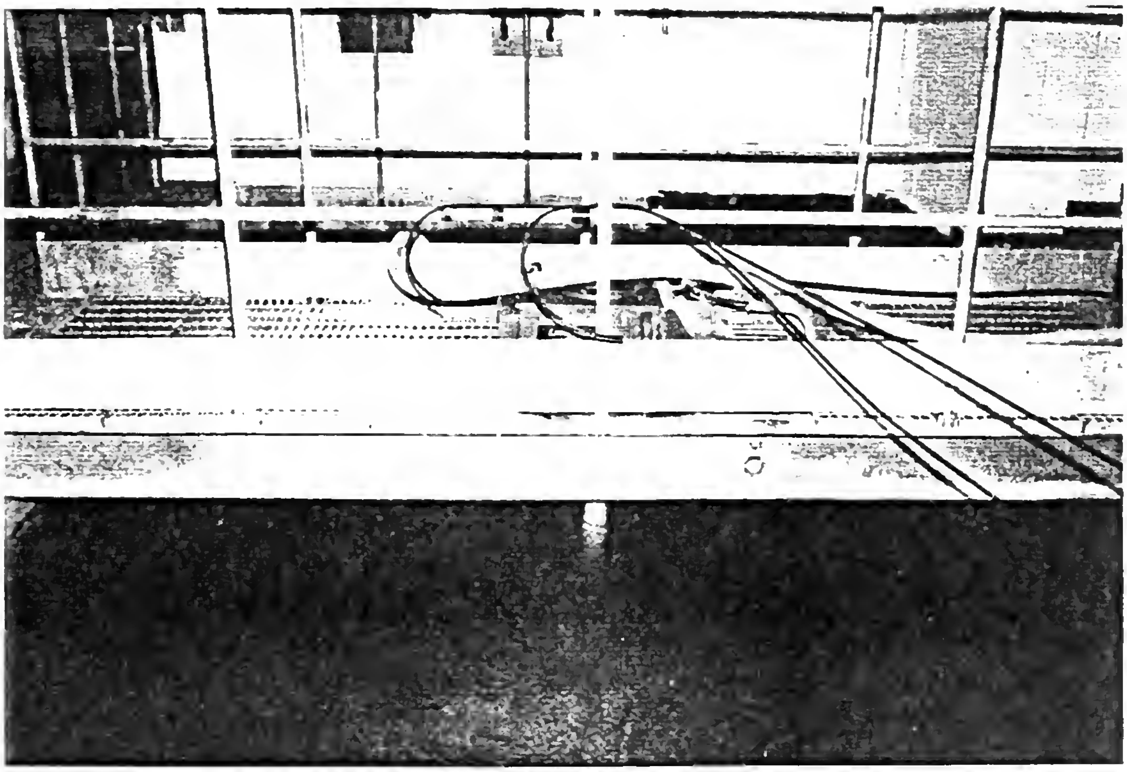


PHOTO NO. 6 - 1985 RAPID MIX TANK
AND MOTOR GEAR REDUCER FOR MIXER

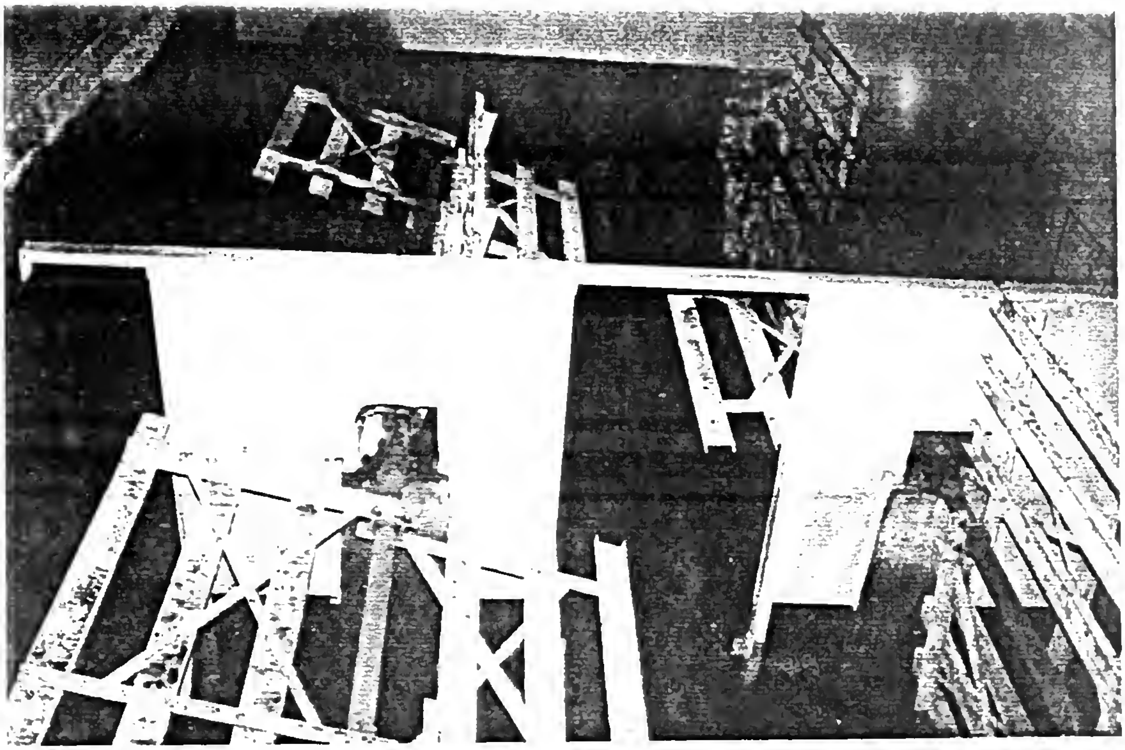


PHOTO NO. 7 - 1972 FLOCCULATOR

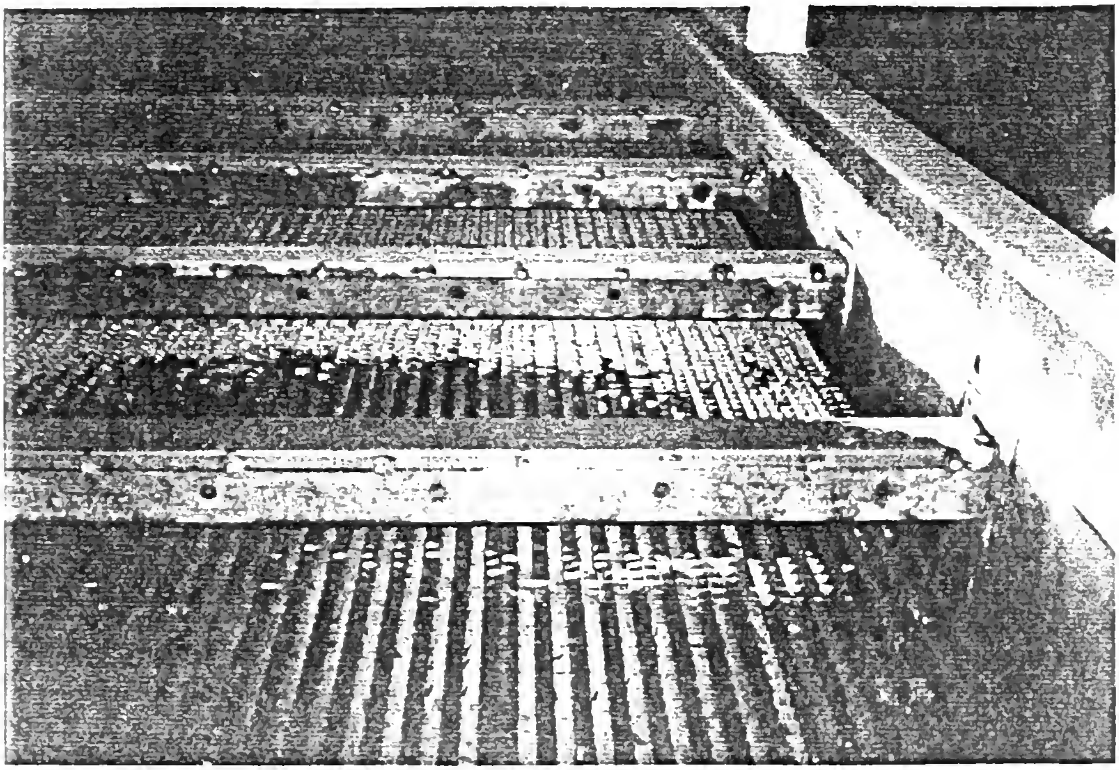


PHOTO NO. 8 - SETTLING TANKS SHOWING TUBE SETTLERS AND CLARIFIED WATER COLLECTORS

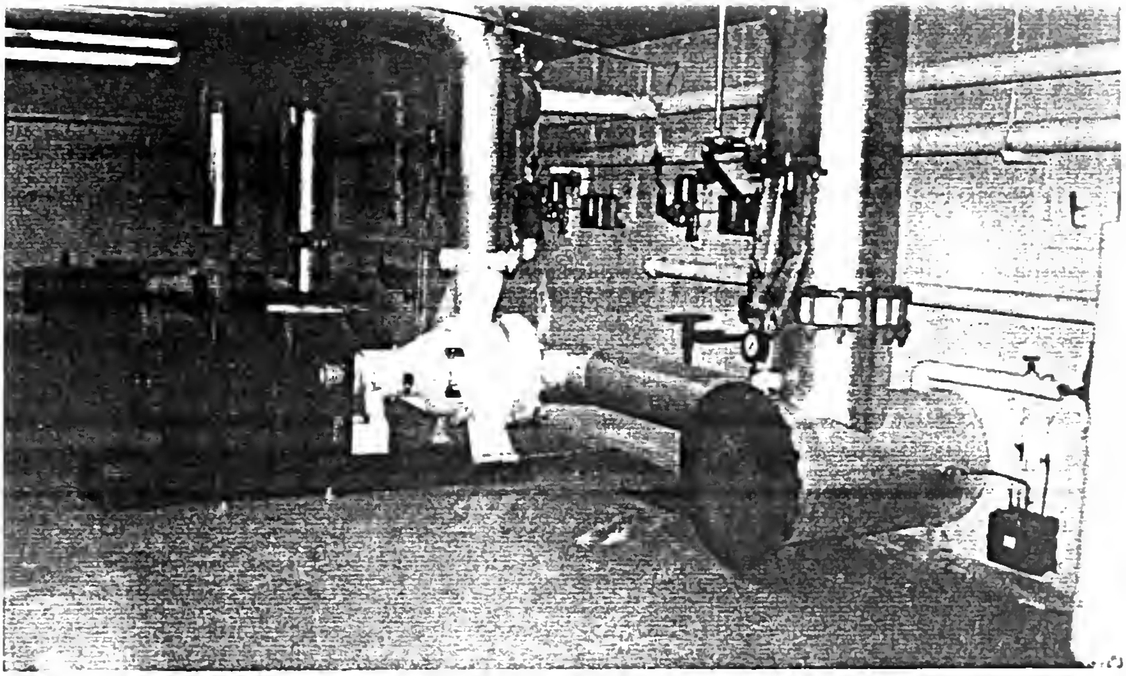


PHOTO NO. 9 - 1972 FILTER GALLERY

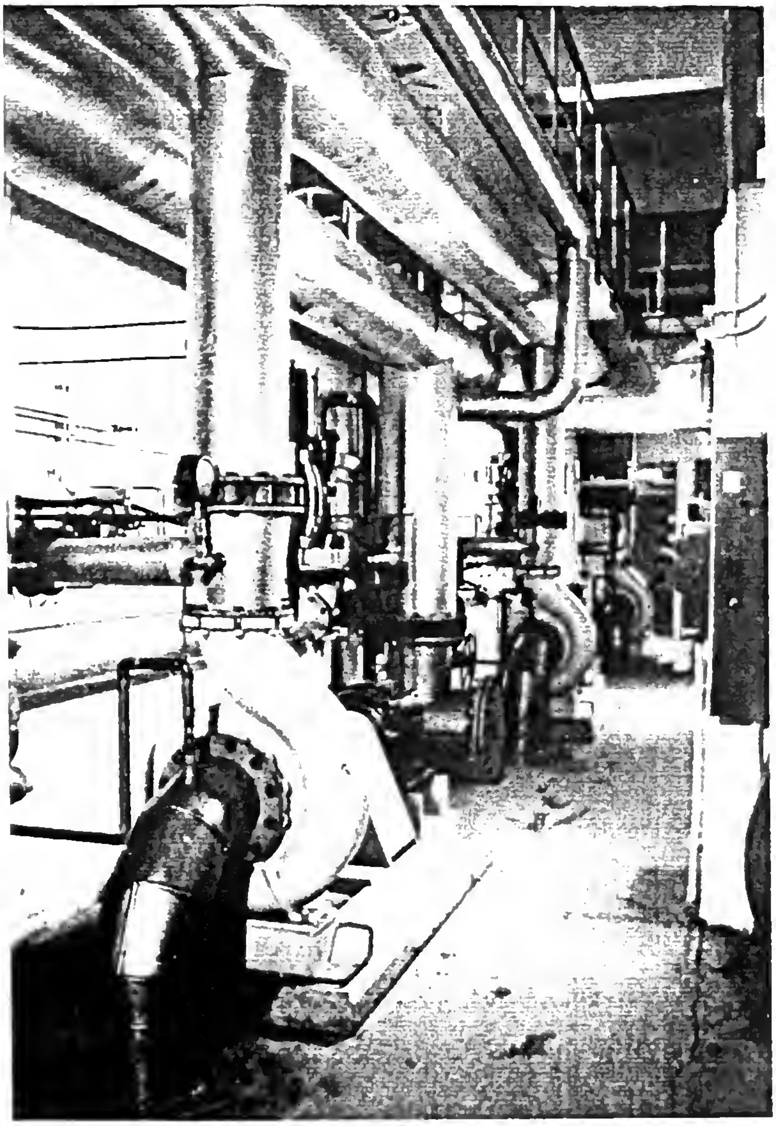


PHOTO NO. 10

1985
FILTER GALLERY

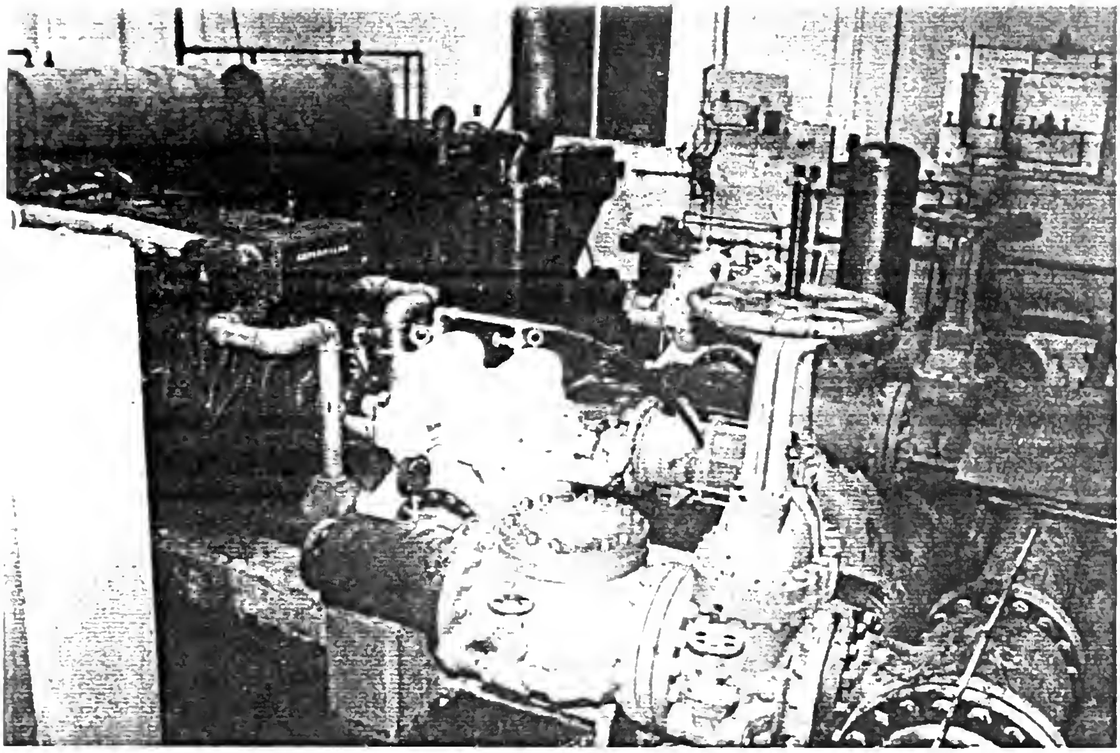


PHOTO NO. 11
ENGINE DRIVEN HIGH LIFT PUMPS NO. 1 AND NO. 2

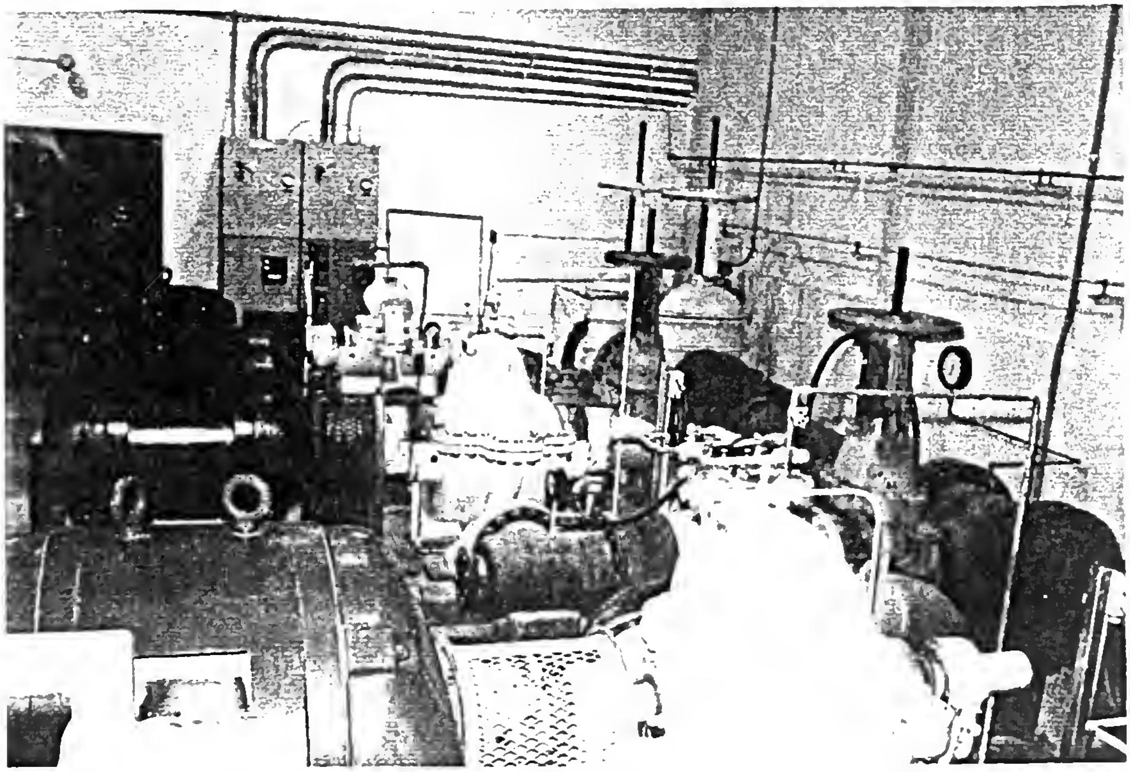


PHOTO NO. 12
HIGH LIFT PUMPS NO. 3 NO. 4 AND NO. 5

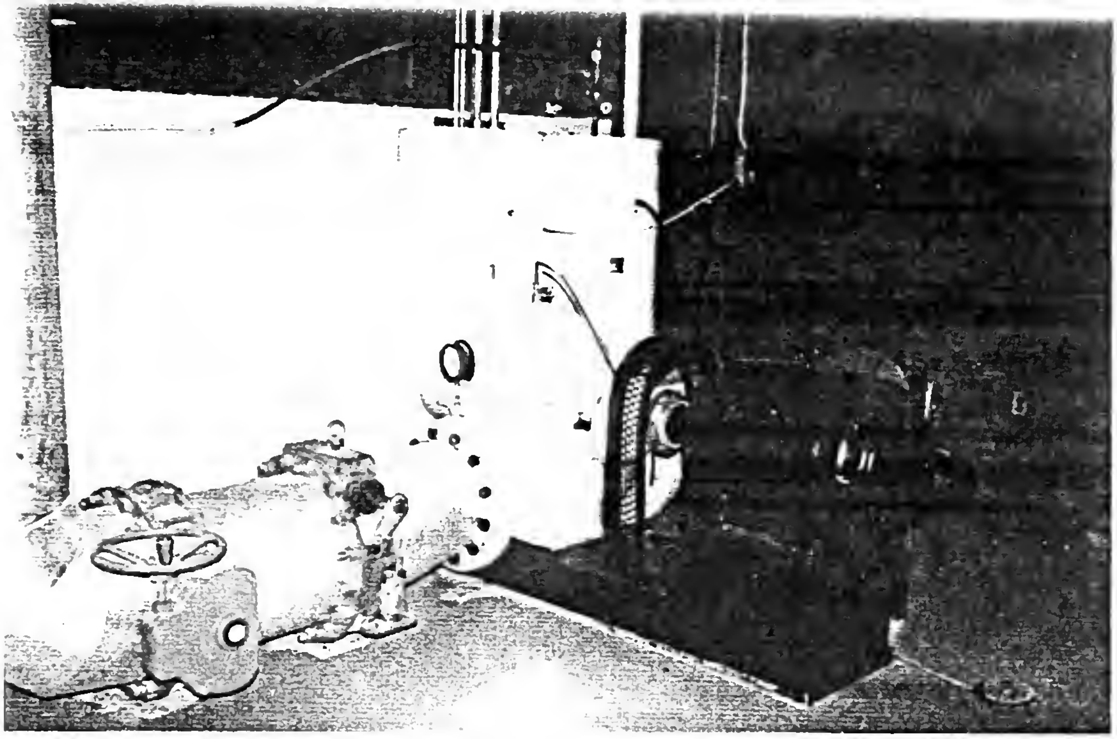


PHOTO NO. 13 - BACKWASH PUMP

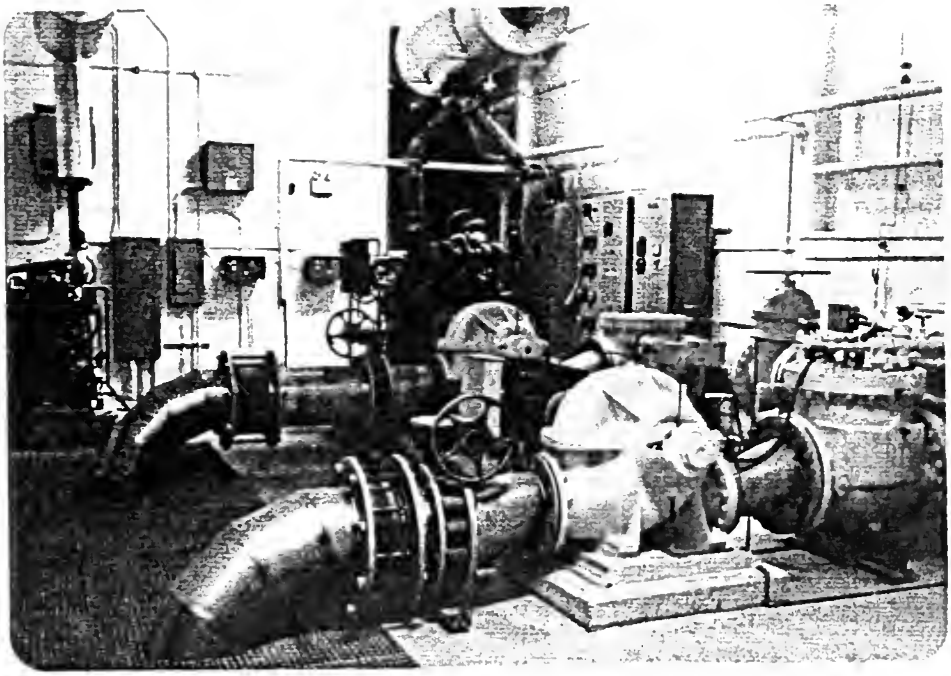


PHOTO NO. 14
HIGH LIFT PUMPS NO. 7 AND NO. 8

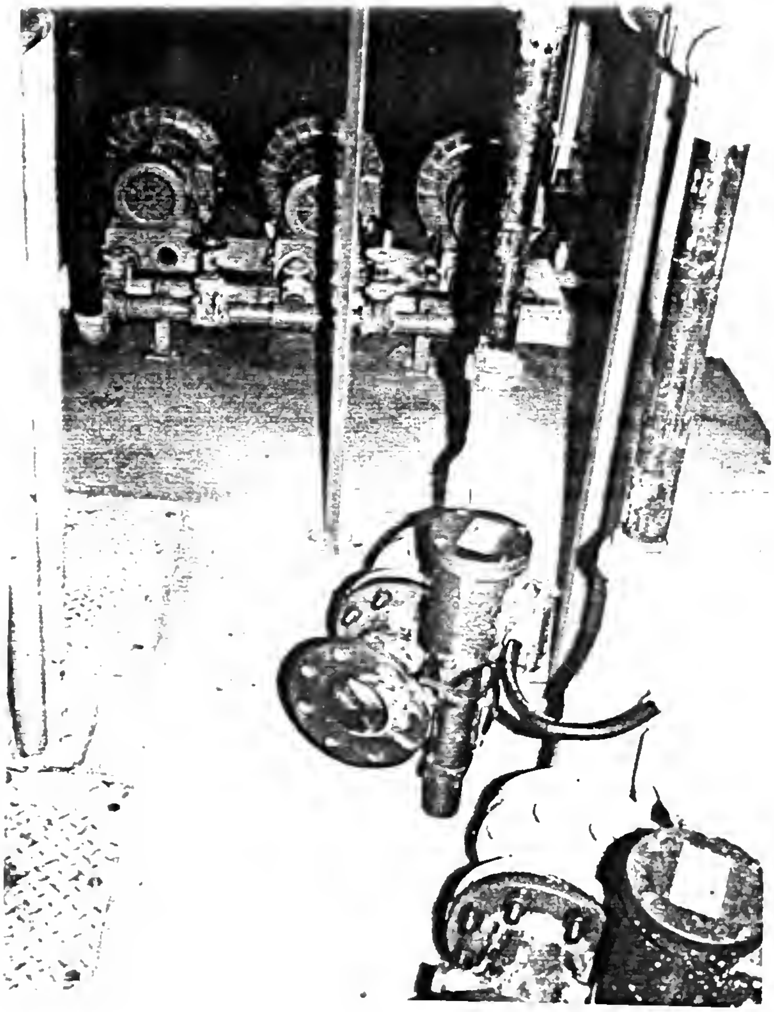


PHOTO NO. 15

PULSATOR
VACUUM BLOWERS
AND
SOLENOID VACUUM
BREAKING VALVES

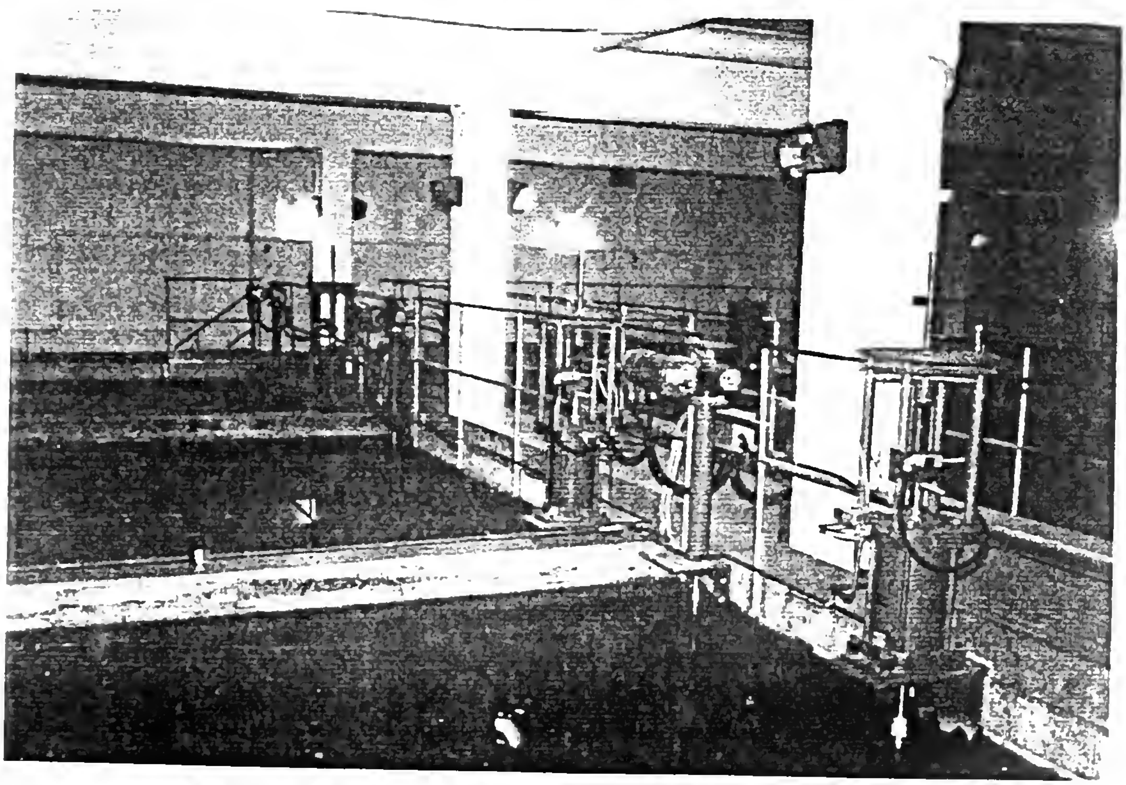


PHOTO NO. 16 - DEGREMONT FILTERS

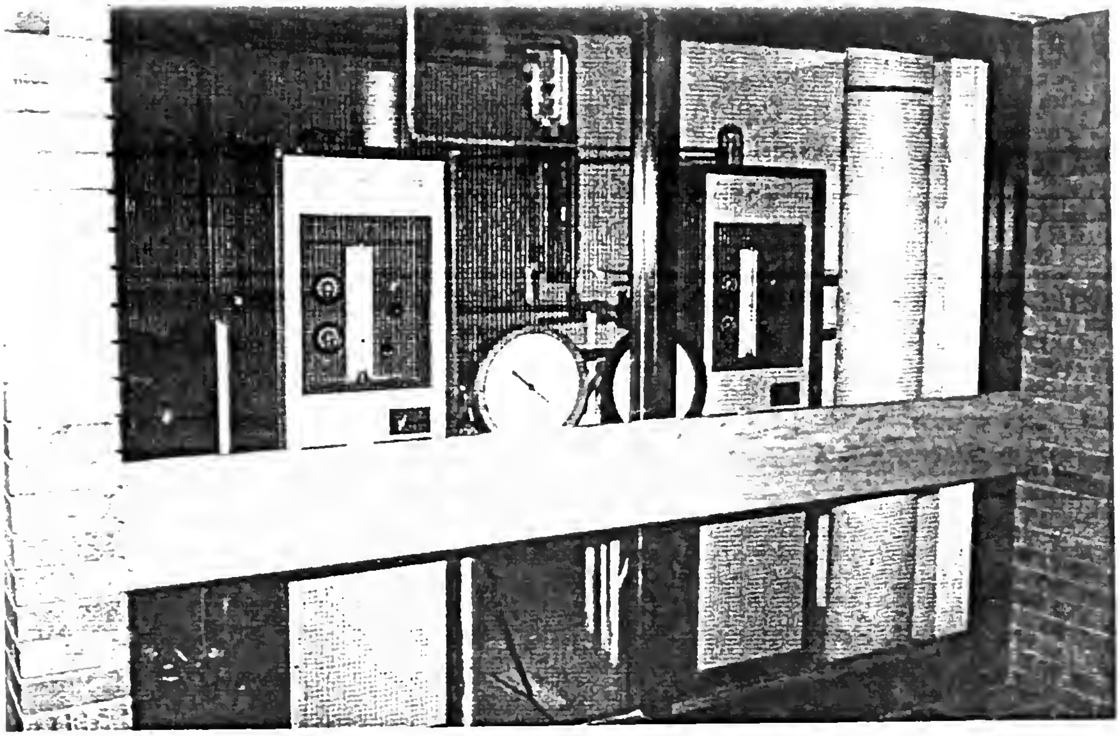


PHOTO NO. 17
PRE AND POST CHLORINATORS AND WEIGH SCALE DIALS

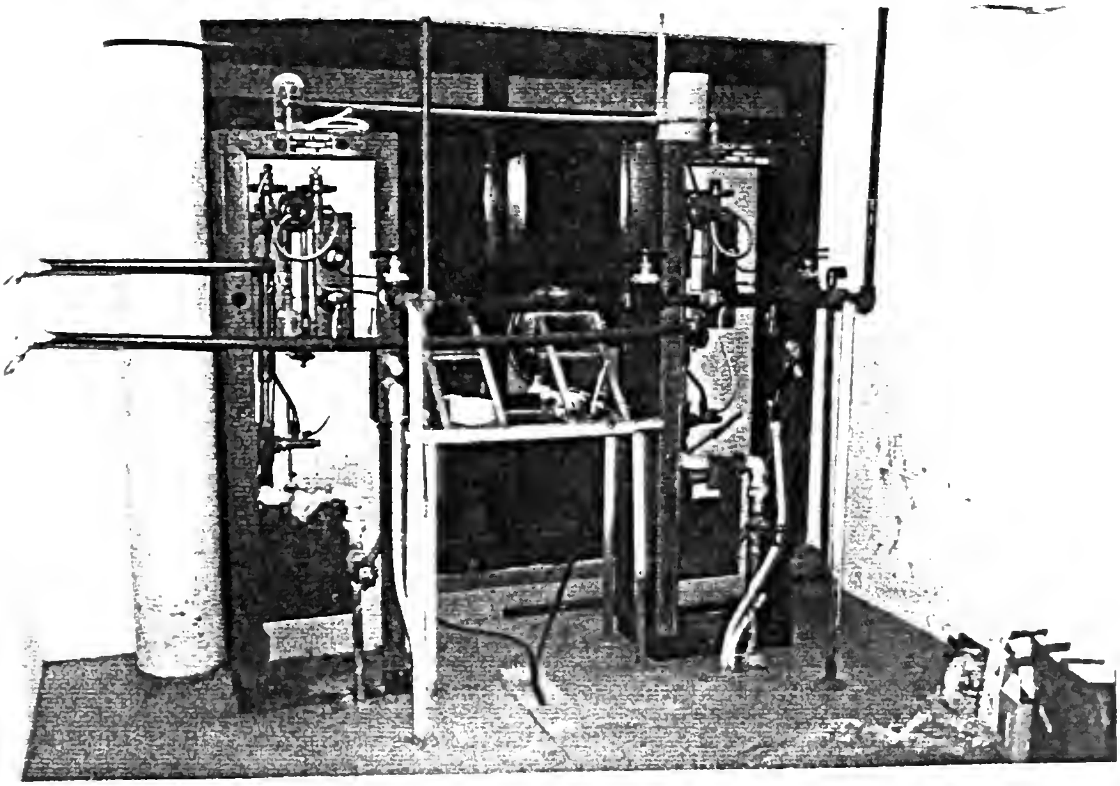


PHOTO NO. 18
PRE AND POST CHLORINATORS

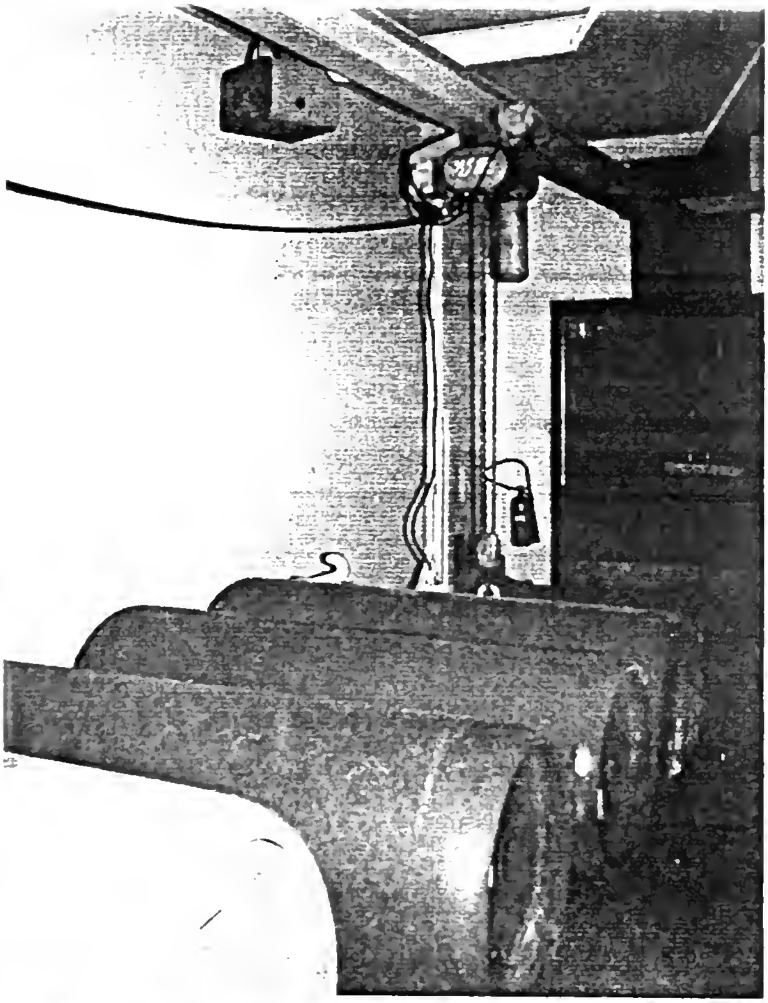


PHOTO NO. 19

CHLORINE CONTAINER STORAGE

PHOTO NO. 20 - CHLORINE WEIGH SCALES

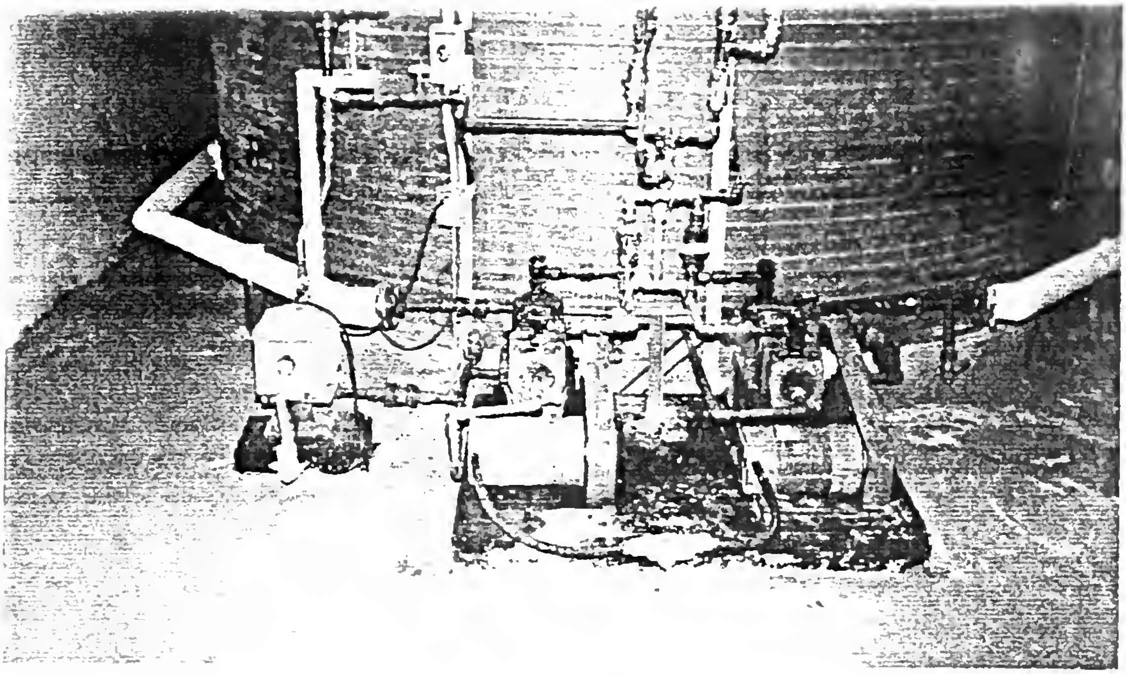


PHOTO NO. 21
LIQUID ALUM STORAGE TANK
ALUM PUMPS AND SUPPLEMENTARY ALUM PUMP

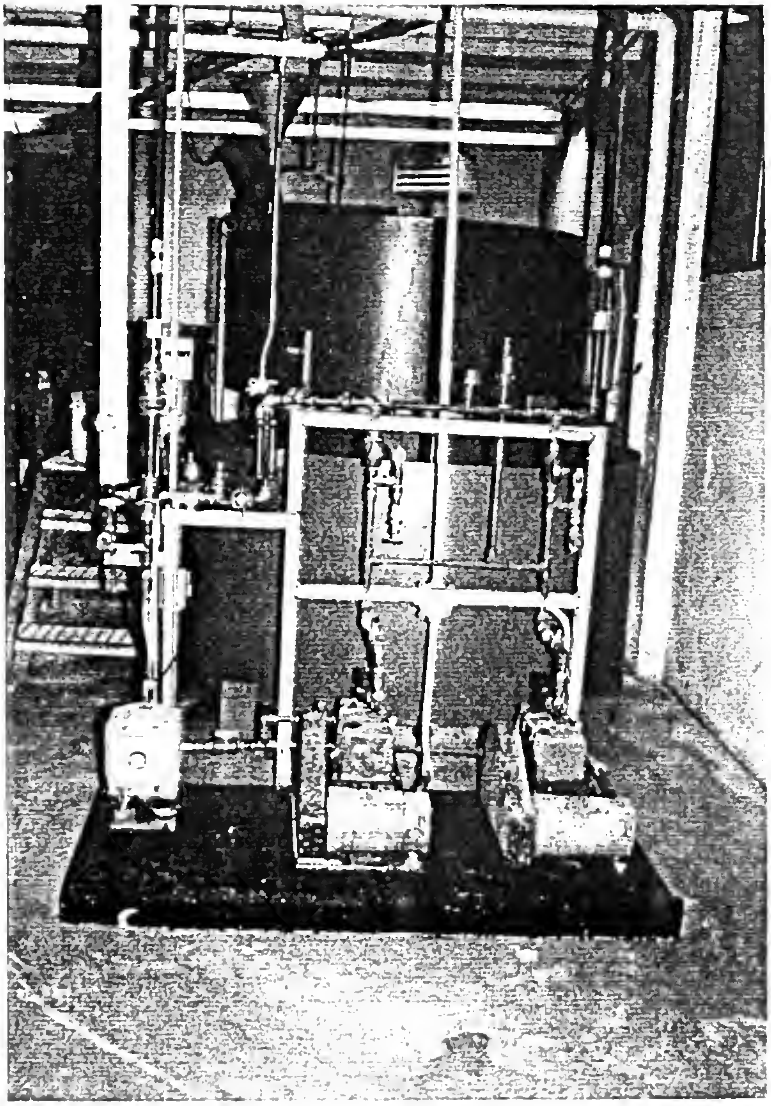


PHOTO NO. 22

POLYELECTROLYTE
MIX AND FEED
TANKS

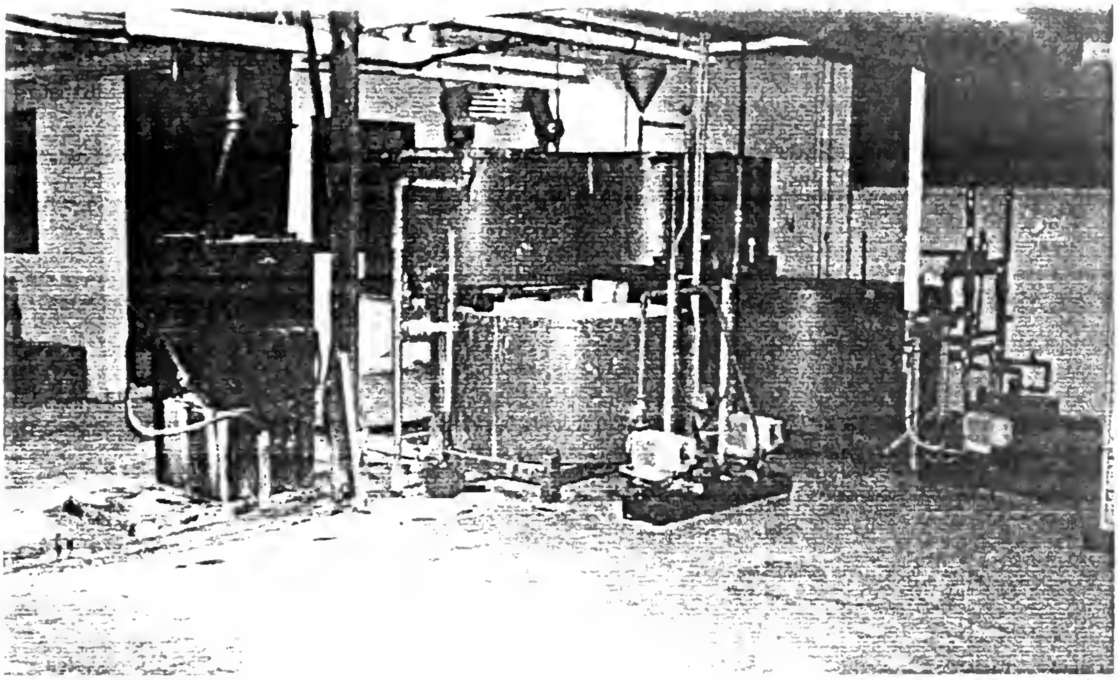


PHOTO NO. 23
LIME FEEDER FOR ALKALINITY CONTROL (LEFT)

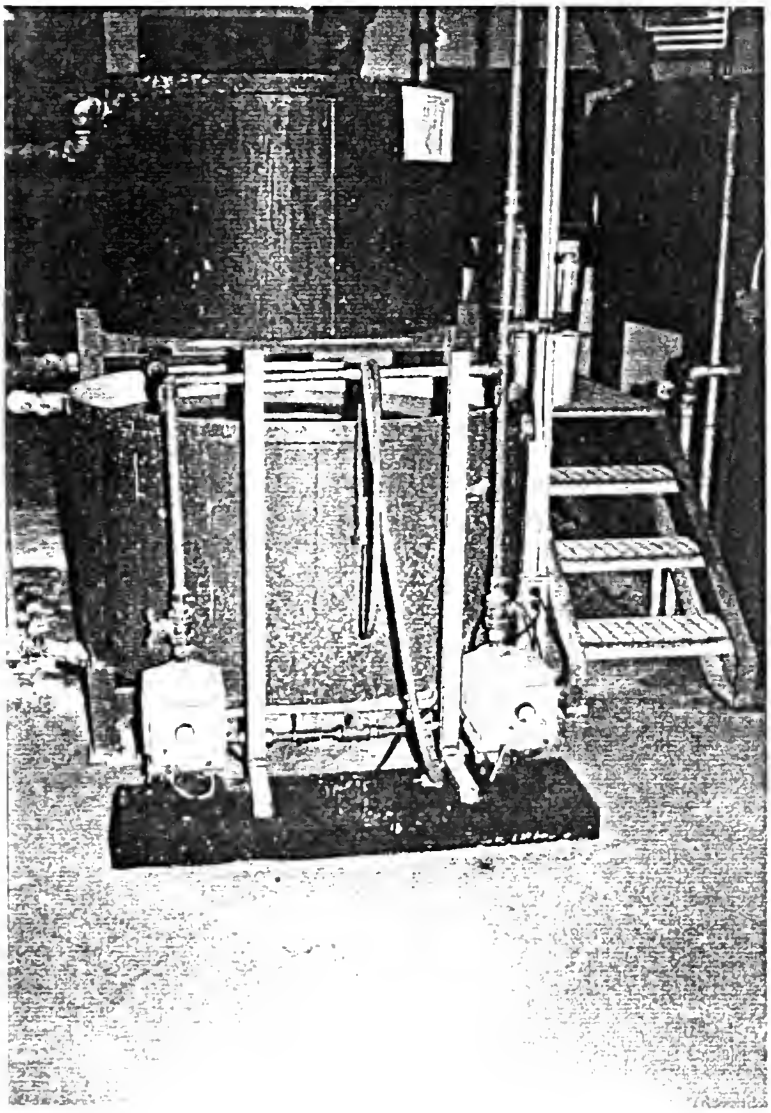


PHOTO NO. 24

ZINC POLYPHOSPHATE
MIX AND FEED TANKS

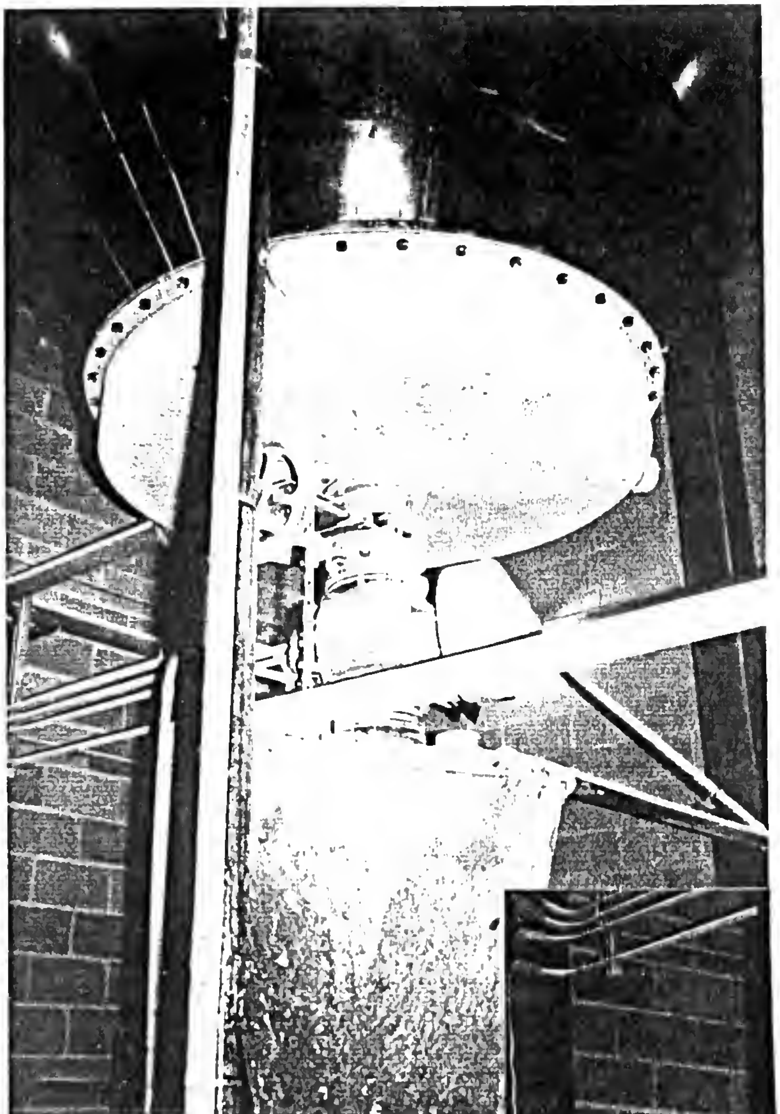


PHOTO NO. 25

LIME SILO
AERATED BOTTOM
BATCH FEEDER AND
DAY BIN

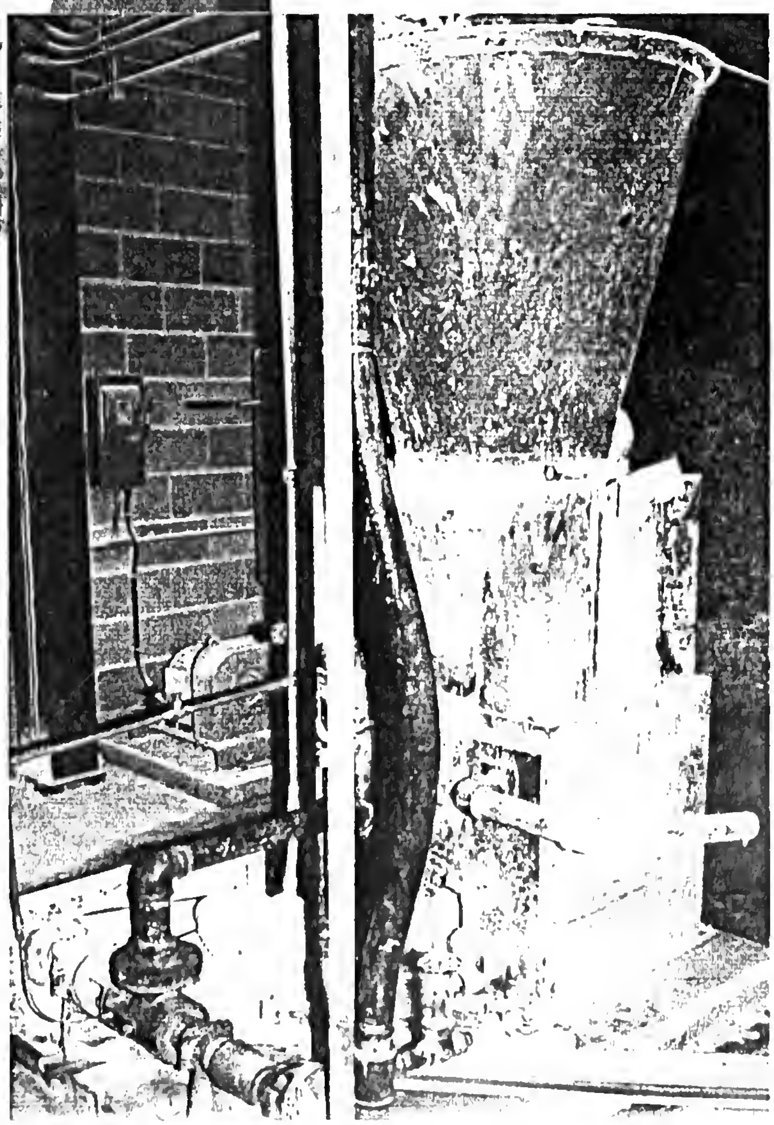


PHOTO NO. 26

LIME FEEDER AND
LIME SLURRY PUMP

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 2

BUFFALO-ANKERITE WATER TREATMENT PLANT

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 2

BUFFALO-ANKERITE WATER TREATMENT PLANT

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WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 2

BUFFALO-ANKERITE WATER TREATMENT PLANT

1.0 INTRODUCTION

This volume is the second of the three-part Optimization Study. Reference should be made to the Introduction to Part 1 for a description of the three separated Timmins water supply systems and the Terms of Reference for the Optimization Study.

The Buffalo-Ankerite system was constructed in 1985 by the City to serve the needs of a small isolated residential mining community, formerly served by a private system. The serviced population is estimated at 250 persons and consideration is being given to expand the system to also serve the Delmite property, i.e. adding about 100 persons. There are no commercial or industrial users and no fire protection is provided. The system is by far the smallest of the three supplies owned and operated by the City and because of its limited size, the scope of this report has been limited to a short description and to reporting the performance data for two months per year only. Because the system started up in 1985, only one year of records was available.

SECTION A - RAW WATER SOURCE

The source of water is McDonald Lake, a very small lake at the headwaters of the South Porcupine River. Raw water colour varies from 5 to 30 and turbidity is generally below 10. The water has moderate hardness (100 - 120) and alkalinity (90 - 100). It is reported that there were occasional taste and odour problems with the water supplied by the original private system. This led to the choice of activated carbon as the media for the new filters.

SECTION B - FLOW MEASUREMENT

Raw water is not metered. Finished water pumped to the distribution passes through a 75 mm diameter turbine meter, Pulser Model FP-30 with pulse duration signal generator.

SECTION C - PROCESS COMPONENTS

No record plans could be located for information on the intake. It is believed that the intake structure is at a depth of about 5 m, extending some 100 m into the lake. The intake pipe terminates into a new 1.6 m square manhole, from where a 250 mm diameter pipe leads to the raw water well.

The concrete raw water well and the two clear wells are below the main floor of the treatment building. The building itself, shown on photograph #1, consists of one room, containing all pumps, filters and feeders.

The rated capacity of the system is reported to be .613 ML/d (7.1 L/s). The following are the main components:

* Raw water well: 1.6 x 5.2 x 2.0 = 16.6 m^3.

* Clear wells: 2 cells of 15 m^3 each.

* Low lift pumps: 3 Darling Model 2-1.5 CW, end section, close coupled 3.7 kW motor, 3500 rpm, rated 4.0 L/s @ 33.5 m TDH. Firm capacity: .69 ML/d (8.0 L/s).

* Filters: 3 Culligan Cullar pressure filters, Model HR-48, 1.2 m diameter x 1.5 m sidewall, prefabricated steel units.

* Total filter area: 3.4 m^2.

* Filter media: 0.5 m deep Cullar #1627 lignite base granular activated carbon. 0.5 m deep fine, medium and coarse support gravel surrounding a piped underdrain system.

* Maximum filter rate: 13.1 m/hr at 4.1 L/s per filter.

* Average filter rate: 2.0 m/hr at 0.63 L/s per filter.

* Filter backwash: fully automatic, time initiated, set for 10 minute backwash, 10 minute purge (filter-to-waste). Each filter is backwashed once every 24 hours.

* Backwash rate: 7.5 L/s or 23.9 m/hr.

* High lift pumps: 2 Darling Model 2-1.5 CA, end suction, close coupled, 11.2 kW motor, 3500 rpm, rated 4.7 L/s @ 61.0 m TDH. Firm capacity .41 ML/d (4.7 L/s).

* Pre-chlorination: 135 L solution tank for use with 12% liquid sodium hypochlorite. 1 Metronics Model B-711-91T solenoid powered metering pump, maximum capacity 143 L/d. Pump is synchronized with low lift pumps and feeds at a constant rate. Solution is fed to the inlet pipe of the raw water well.

* Post chlorination: 135 L solution tank for use with 12% liquid sodium hypochlorite. 1 Metronics Model B-711-91T solenoid powered metering pump, maximum capacity 143 L/d. Pump is controlled by 4-20 MA signal from finished water flow meter. Solution is pumped into the clear wells.

* Flow meter: Pulser Model FP-30 turbine meter with 4-20 MA signal generator.

* Backwash treatment: filter backwash is discharged into two 9000 L precast septic tanks. Tank effluent is directed to the outflow of McDonald Lake.

SECTION D - PLANT OPERATION

D:1.1 **Operation**

The distribution system consists of 75 and 100 mm diameter cement-lined ductile iron piping. There are no fire hydrants. One high lift pump is always running, the second unit starts on low pressure. Over pressure is relieved through a pressure relief valve that returns excess water to the clear wells. The low lift pumps are controlled by the level in the clear wells.

There is no elevated tank and no generator for emergency power, nor are there any engine driven pumps. In case of power failure, the entire system becomes depressurized. A power failure alarm is transmitted to the Timmins Treatment Plant.

The pre- and post-chlorination dosage rates are aimed to achieve 0.5 mg/L free chlorine. The plant is visited three times a week and records are made of the water meter totallizer, chlorine consumption, clear well water level and system water pressure.

Samples are taken of raw and system water three times a week, which are analyzed on-site for free chlorine residual, and at the Water Treatment Plant for pH, colour and turbidity. Once a month samples of raw and finished water are submitted to the Ministry of the Environment laboratory in Toronto for analysis of the constituents. The results are listed in Table 4.0.
A bacteriological sampling and testing program by waterworks plant personnel did not commence until February, 1987. Table 6.0 shows test results for 1987.

D:2 **Validity of Data Collected**

The flow meter data is presented in Table No. 1, Daily Flow Table. No fill or draw test was conducted to check the meter. Being of a mechanical type and very new, it can be considered as accurate.

The information collected on quantities of chlorine used is based on volumes of 12% sodium hypochlorite, supplied in 20 L containers.

Regarding the accuracy of the laboratory analyses performed in the Timmins Water Treatment Plant on samples taken from the system, reference should be made to Part 1 of the Optimization Study.

SECTION E - PLANT PERFORMANCE

E:1 Particulate Removal

The coarse media in the carbon filters are not suitable for consistent and efficient removal of turbidity. This conclusion is confirmed by the water quality records shown in Table 2.1.

The carbon media are moderately effective in removing colour. This property will however decrease as more water is treated.

E:2 Disinfection

Samples for bacteriological testing are collected three times per week, from the system water leaving the plant and from homes near the end of the distribution system. All testing results since February, 1987, when bacteriological sampling was first introduced, were negative for Total and Fecal Coliform. Background bacteria were found in 7 out of 105 samples.

Sodium hypochlorite is added to the raw water. Any residual chlorine will be quickly removed by the carbon media in the filters. Post-chlorination therefore becomes an important aspect of the disinfection procedure. Table 3.0 Disinfection Summary, June 1986, illustrates that free chlorine residual is sometimes difficult to maintain. Increased dosages are suggested.

SECTION F - POSSIBLE SHORT AND LONG TERM MODIFICATIONS

F:1 Short Term Modifications

In the short term, it is suggested that at least one or two distribution system samples be collected every visit, for free chlorine residual analysis. The chlorine dosage to the finished water should be increased to obtain higher residuals. Chlorine demand testing should be introduced to better judge the initial settings for the post-chlorinator. A continuously recording chlorine analyser should also be considered. The carbon media should be inspected once a year for level and grain size distribution, because this material is rather soft and will be wearing relatively quickly. Finally, colour removal averages should be graphed to monitor the decrease in colour absorption of the carbon media. In time, the carbon will have to be replaced completely.

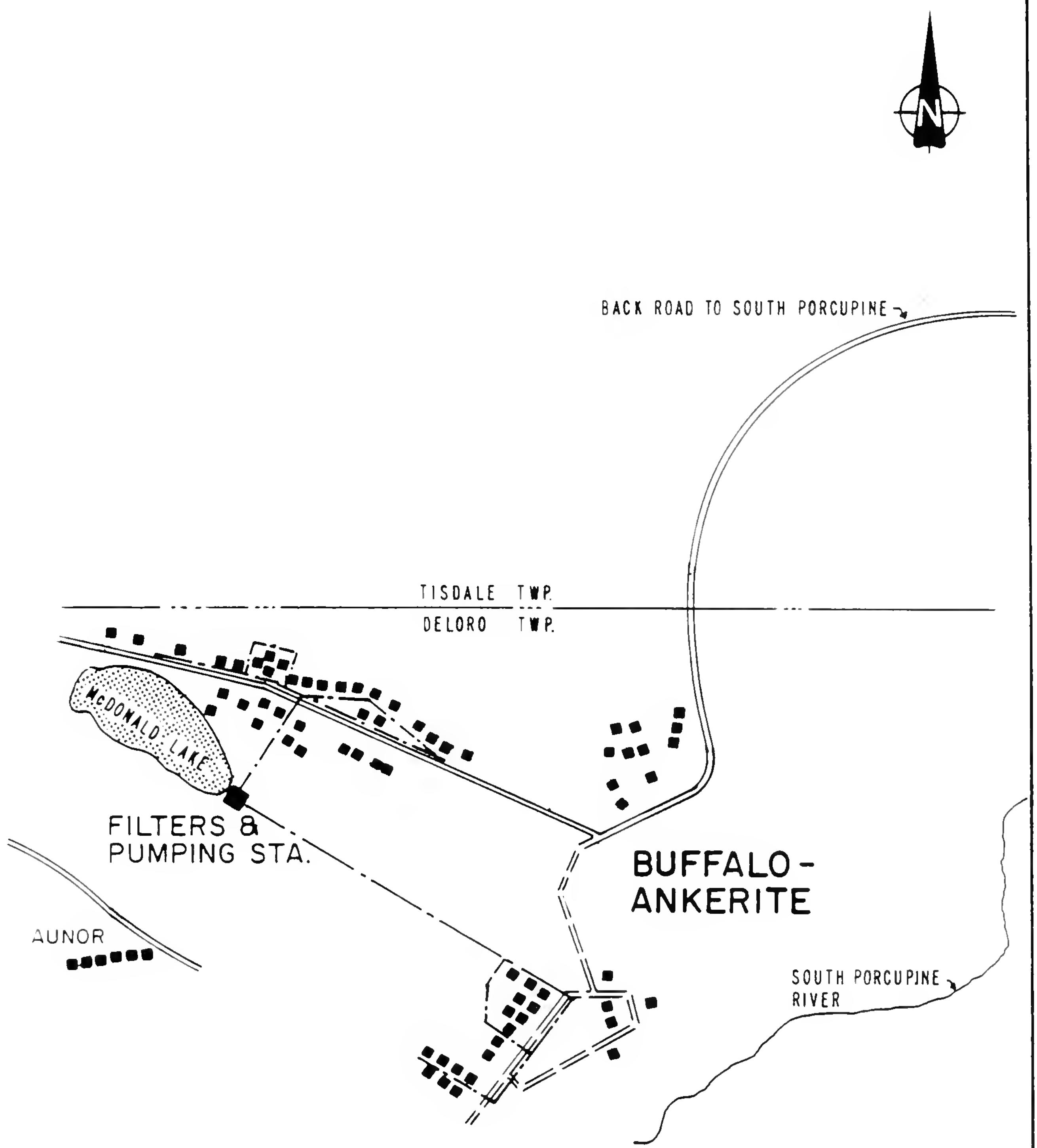
It is recommended that a residual chlorine analyser and recorder be installed, at a cost of $5,000.

Secondly, consideration should be given to the addition of an automatic starting diesel generator to prevent the distribution system from being depressurized and drawing a partial vacuum during a power outage, and thus eliminate the accidental entry of contaminated groundwater through leaky joints. The estimated cost of a building addition, generator and transfer switch is approximately $70,000.

F:2 Long Term Modifications

The water quality testing records indicate that turbidity and colour removal is not as efficient as desirable, which is of course to be expected from this type of plant. In order to produce consistently a finished water with turbidity of less than

1.0 FTU and colour of less than 5.0 TCU, it will be necessary to precede the carbon filters with conventional pretreatment equipment. It is possible that sand filters may also be required to reduce the effluent turbidity. Alternatively the carbon media could be replaced by sand.

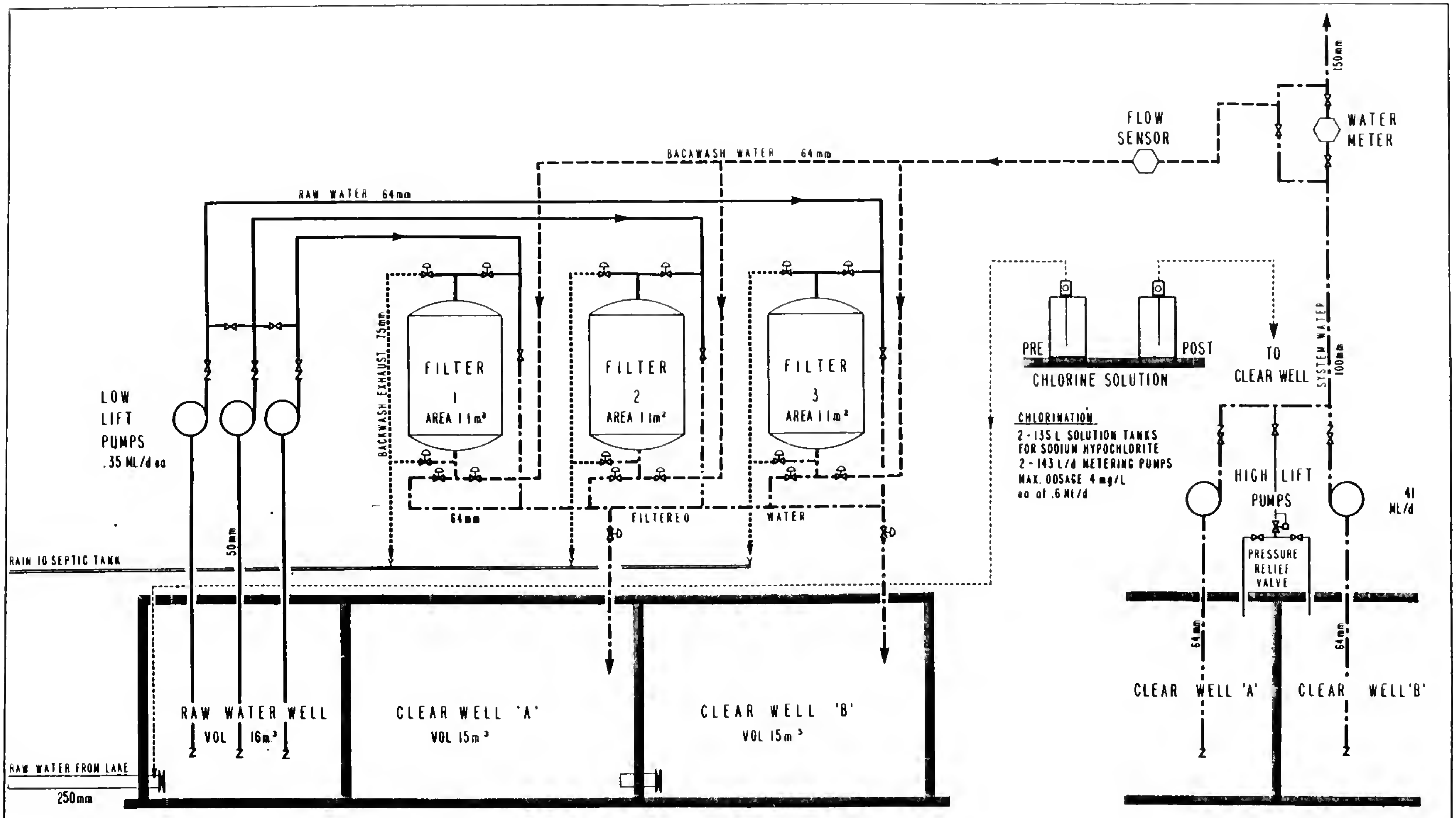


BUFFALO - ANKERITE

SITE PLAN

SCALE 1 : 18000

Fig. 1



BUFFALO - ANKERITE
PROCESS & PIPING
DIAGRAM

BUFFALO-ANKERITE

TABLE NO. 1.0: DAILY FLOWS (ML/d) FOR 1986

DAY	1986	
	JANUARY	JUNE
1		
2		0.468
3	0.464	
4		0.268
5		
6	0.442	0.332
7	0.151	
8	0.143	
9	0.144	0.477
10	0.146	
11		
12		1.086
13	0.404	0.141
14	0.157	
15	0.143	
16	0.136	0.443
17	0.159	
18		0.211
19		
20	0.416	0.295
21		
22	0.259	
23	0.142	0.550
24	0.151	
25		0.219
26		
27	0.420	0.199
28		
29	0.284	
30		0.223
31	0.312	
TOTAL	4.473	4.912
AVG.	0.144	0.164

NOTE: Flows shown are quantities read after intervals of 1, 2, 3 or 4 days

Source: Plant records

BUFFALO-ANKERITE

TABLE NO. 1.1: PER CAPITA CONSUMPTION (L/D/CAP)

Population: 250

Consumption in January, 1986: 576 L/D/cap

Consumption in June, 1986: 656 L/D/cap

BUFFALO-ANKERITE

TABLE NO. 2.0: PARTICULATE REMOVAL SUMMARY

	JANUARY 1986						JUNE 1986					
	pH		COLOUR		TURBIDITY		pH		COLOUR		TURBIDITY	
	R	T	R	T	R	T	R	T	R	T	R	T
1												
2							7.4	7.3	55	15	3.0	0.5
3	7.2	7.4			0.8	1.1						
4							7.1	7.4	30	15	1.0	1.6
5												
6	7.5	7.8			0.6	0.5						
7	7.4	7.6			0.8	1.0	7.3	7.3	30	20	0.8	0.4
8	7.6	7.5			0.6	0.7						
9							7.3	7.3	30	15	0.8	0.5
10	7.4	7.5			2.0	0.8						
11							7.4	7.2	15	10	1.6	1.1
12												
13	7.3	7.4			0.8	0.6						
14	7.4	7.4			1.3	0.3						
15												
16							7.6	6.8	40	10	3.2	1.2
17	7.2	7.5	5	5	0.5	1.0						
18							7.6	7.5	5	5	0.6	0.4
19												
20	7.5	7.4	7	15	0.6	5.8						
21	7.3	7.4	8	5	1.0	1.0	7.8	7.3	15	10	7.8	1.3
22												
23							7.5	7.3	35	18	2.6	0.5
24	7.4	7.6	10	5	0.4	0.5						
25							7.3	7.3	25	15	1.4	0.6
26												
27	7.6	7.6	30	10	2.4	1.0						
28							7.5	7.4	18	15	0.8	0.1
29	7.4	7.6	15	10	0.5	1.1						
30							7.4	7.3	18	20	0.7	1.1
31	7.3	7.6	5	5	0.4	0.8						
MAX.			30	15	2.4	5.8			55	20	7.8	1.6
MIN.			5	5	0.4	0.3			5	5	0.6	0.1
AVG.			11.4	7.8	.91	1.16			26.3	14.0	2.03	.78

NOTE: All testing performed at Timmins Water Treatment Plant

Source: Plant records

BUFFALO-ANKERITE

TABLE NO. 3.0: DISINFECTION SUMMARY FOR 1986

DAY	JUNE	
	DOSAGE	FREE CHLORINE
1	1.17	
2		0.15
3		
4	1.02	0.0
5		
6	1.23	
7		0.0
8		
9	1.14	0.0
10		
11		0.0
12	0.50	
13	1.93	
14		
15		
16	0.62	
17		
18	1.29	0.0
19		
20	0.92	
21		0.0
22		
23	0.99	0.1
24		
25	1.24	0.15
26		
27	1.37	
28		0.1
29		
30	1.22	0.0
31		
AVG.	0.97	0.05

NOTE: Free chlorine residual 0.0 means residual is not measurable by DPD method.

Source: Plant records

BUFFALO-ANKERITE

TABLE NO. 4.0: WATER QUALITY

	WATER QUALITY 1986			
	JANUARY		JUNE	
	R	T	R	T
Conductivity UMHO/cm	274.	276.	261.	268.
Hardness mg/L	116.	116.	108.	108.
Calcium mg/L	35.5	35.5	--	--
Magnesium mg/L	6.8	6.7	--	--
Sodium mg/L	11.0	11.5	--	--
Potassium mg/L	.50	.50	--	--
Alkalinity mg/L	102.	102.	96.8	96.5
pH	7.47	7.76	8.06	8.21
Fluoride mg/L	.03T	.03T	--	--
Chloride mg/L	18.8	19.2	19.4	21.7
Sulphate mg/L	9.5	9.5	--	--
Phosphorus mg/L	.01T	.01W	--	--
Nitrogen mg/L	.3T	.3T	.2T	.2T
Ammonium mg/L	.05W	.05W	.05W	.05W
Nitrates mg/L	.1T	.05W	.05T	.05T
Iron mg/L	NSS	NSS	.13	.05
Manganese mg/L	NSS	NSS	--	--

NOTE: T - This measurement is tentative - for information only.
W - "Zero" value reported is minimum measurable amount.
NSS - No suitable sample.

Source: MOE Laboratory, Toronto

BUFFALO-ANKERITE

TABLE 5.0: ALGAE COUNT

MONTH	COUNT				
January	Max. Min. Avg. No. Tests				
February	Max. Min. Avg. No. Tests				
March	Max. Min. Avg. No. Tests				
April	Max. Min. Avg. No. Tests				
May	Max. Min. Avg. No. Tests				
June	Max. Min. Avg. No. Tests				
July	Max. Min. Avg. No. Tests				
August	Max. Min. Avg. No. Tests				
September	Max. Min. Avg. No. Tests				
October	Max. Min. Avg. No. Tests				
November	Max. Min. Avg. No. Tests				
December	Max. Min. Avg. No. Tests				

NOTE: No data on particulate counting, suspended solids or algae counts is available.

BUFFALO-ANKERITE

TABLE 6.0: BACTERIOLOGICAL TESTING 1987

		TOTAL COLIFORM					FECAL COLIFORM					FECAL STREPTOCOCCUS			
MONTH	R/T	ABSENT	1-5	6-100	101-5000	5000	ABSENT	1-5	6-10	11-500	500	ABSENT	1	2-50	50
JAN	R														
	T														
FEB	R														
	T		--	--	--	--		--	--	--	--				
MAR	R														
	T	11	--	--	--	--	11	--	--	--	--				
APR	R														
	T	10	--	--	--	--	10	--	--	--	--				
MAY	R														
	T	10	--	--	--	--	10	--	--	--	--				
JUN	R														
	T	11	--	--	--	--	11	--	--	--	--				
JUL	R														
	T	11	--	--	--	--	12	--	--	--	--				
AUG	R														
	T	10	--	--	--	--	10	--	--	--	--				
SEP	R														
	T	11	--	--	--	--	11	--	--	--	--				
OCT	R														
	T	10	--	--	--	--	10	--	--	--	--				
NOV	R														
	T	11	--	--	--	--	11	--	--	--	--				
DEC	R														
	T	10	--	--	--	--	10	--	--	--	--				

NOTE: All results are for 100 mL samples. No analysis performed for Fecal Streptococcus.

R = Raw; T = Treated

Source: Public Health Laboratory, Timmins

BUFFALO-ANKERITE

TABLE 7.0: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY INCLUDING ALUMINUM (TREATED WATER AT PLANT)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT
1986			
Jan. 3	Turbidity	1.1 FTU	1.0 FTU
Jan. 20	Turbidity	5.8 FTU	1.0 FTU
Jan. 29	Turbidity	1.1 FTU	1.0 FTU
June 4	Turbidity	1.6 FTU	1.0 FTU
June 11	Turbidity	1.1 FTU	1.0 FTU
June 16	Turbidity	1.2 FTU	1.0 FTU
June 21	Turbidity	1.3 FTU	1.0 FTU
June 30	Turbidity	1.1 FTU	1.0 FTU

NOTE: All testing performed at Timmins Water Treatment Plant.

Source: Plant records

BUFFALO-ANKERITE

TABLE 7.1: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY (DISTRIBUTION SYSTEM)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT

NOTE: No data from the distribution system are available.

PHOTO NO. 1 - WATER TREATMENT PLANT BUILDING

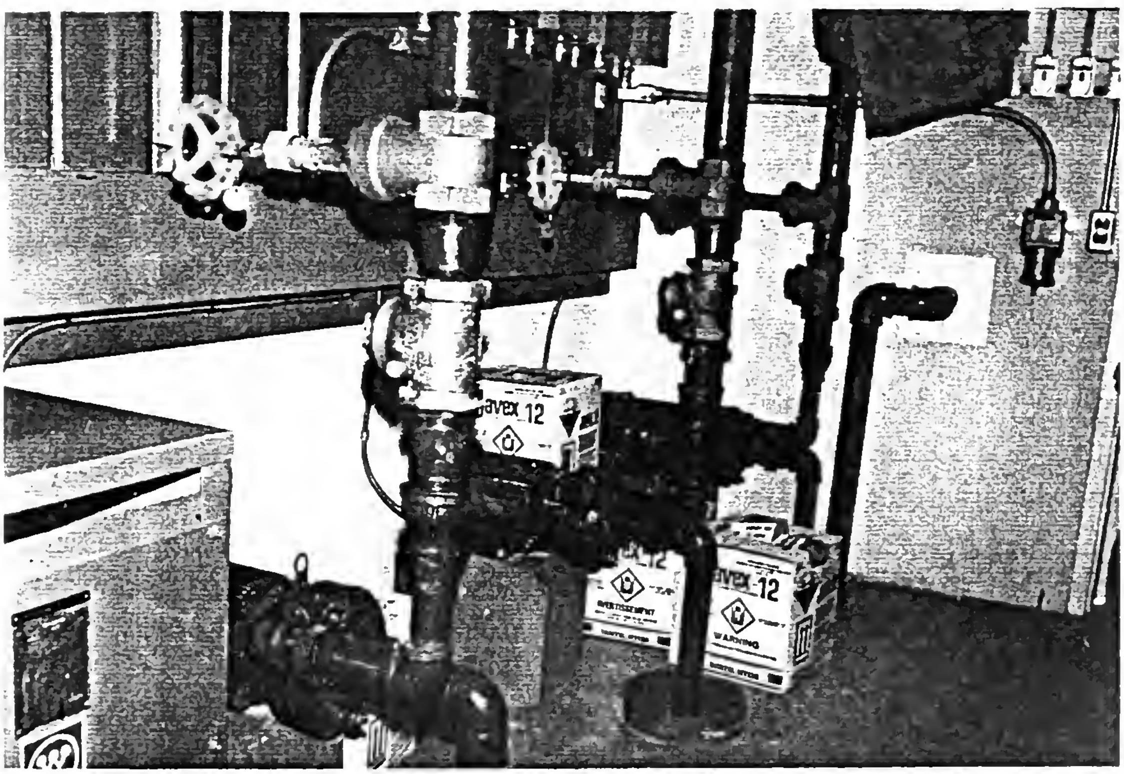


PHOTO NO. 2 - LOW LIFT PUMPS

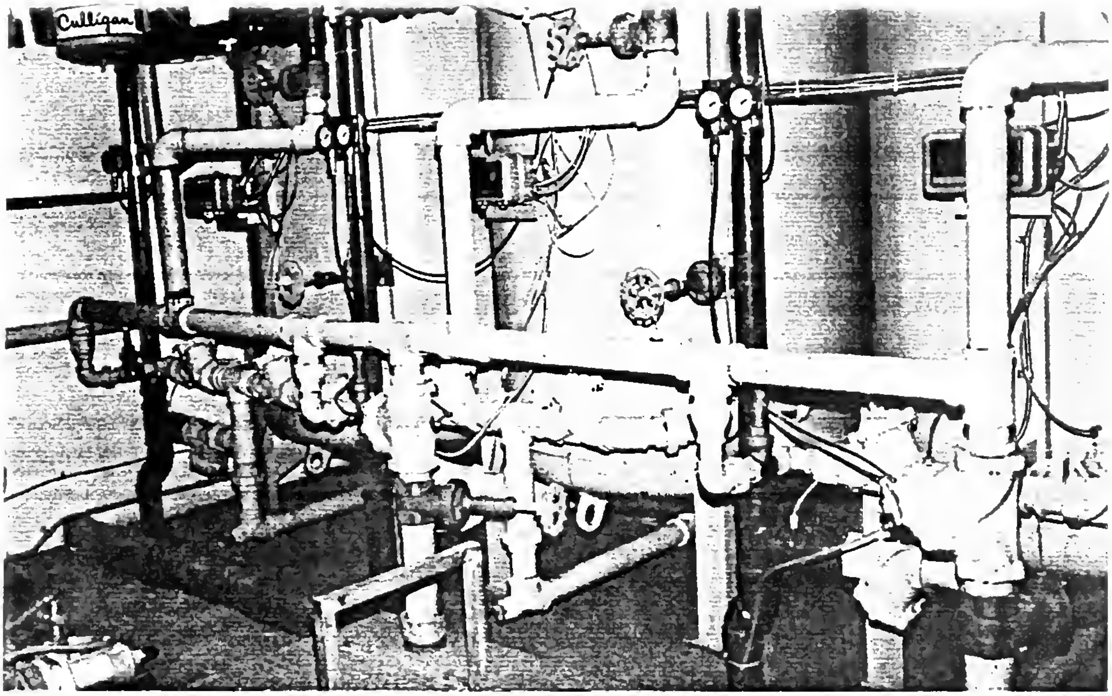


PHOTO NO. 3 - FILTERS

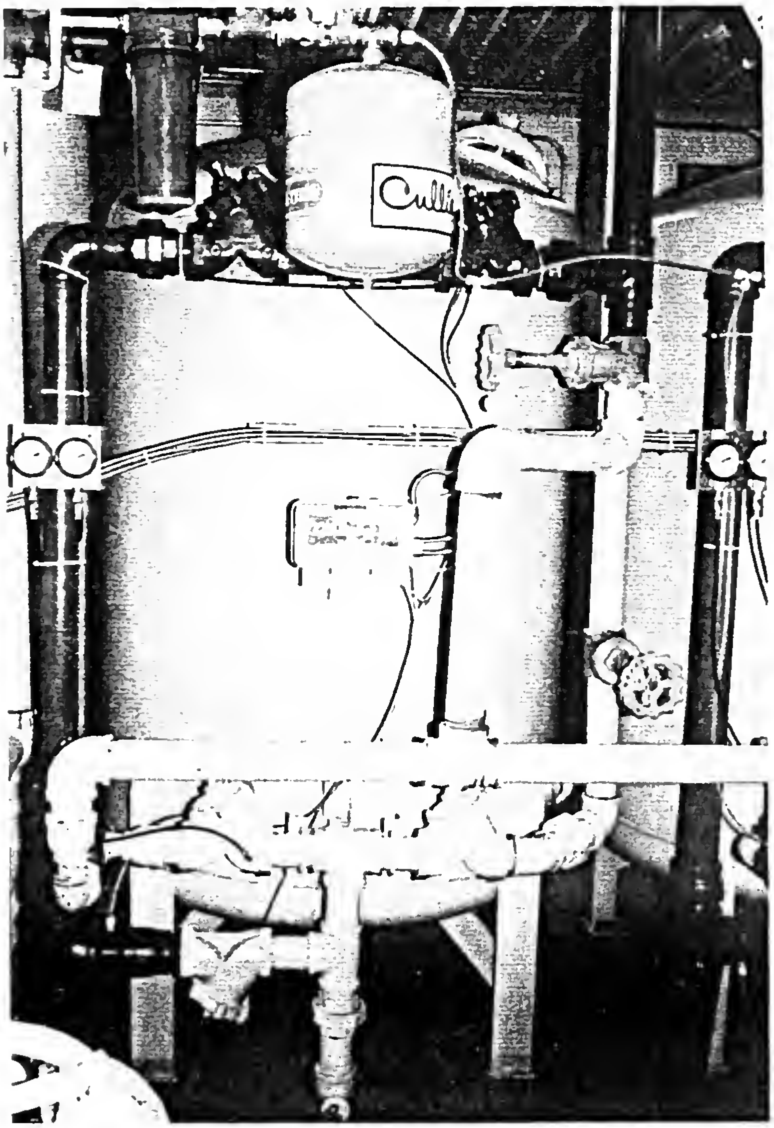


PHOTO NO. 4

STRAINER AND WATER SUPPLY TANK FOR VALVE OPERATORS

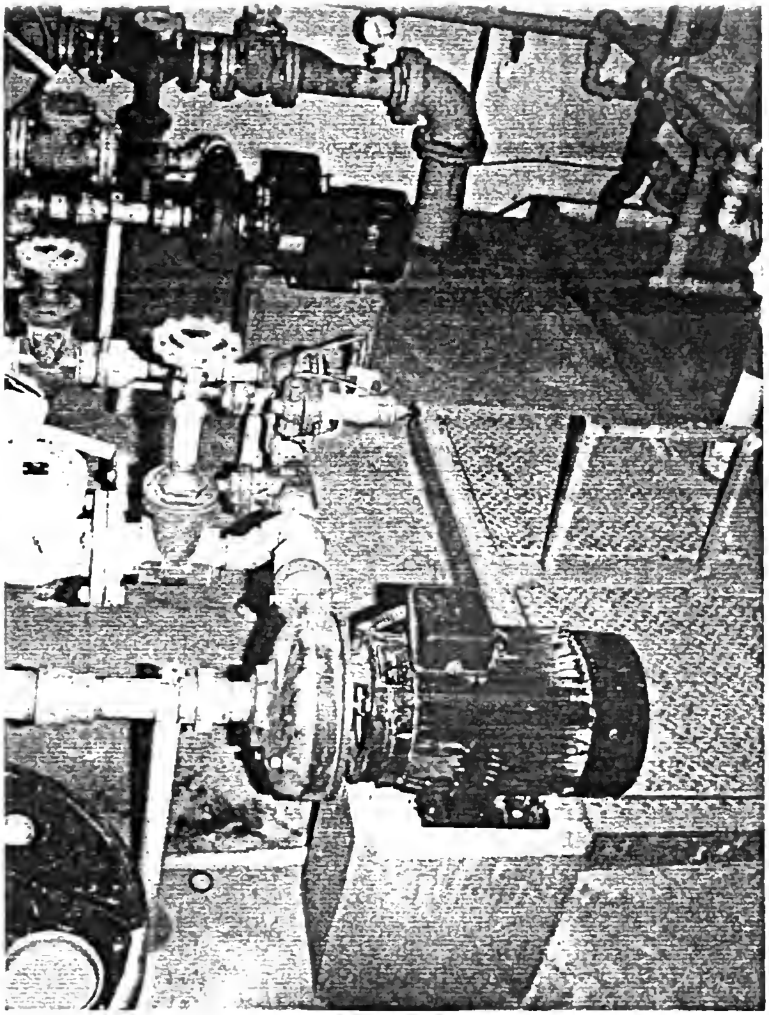


PHOTO NO. 5

HIGH LIFT PUMPS

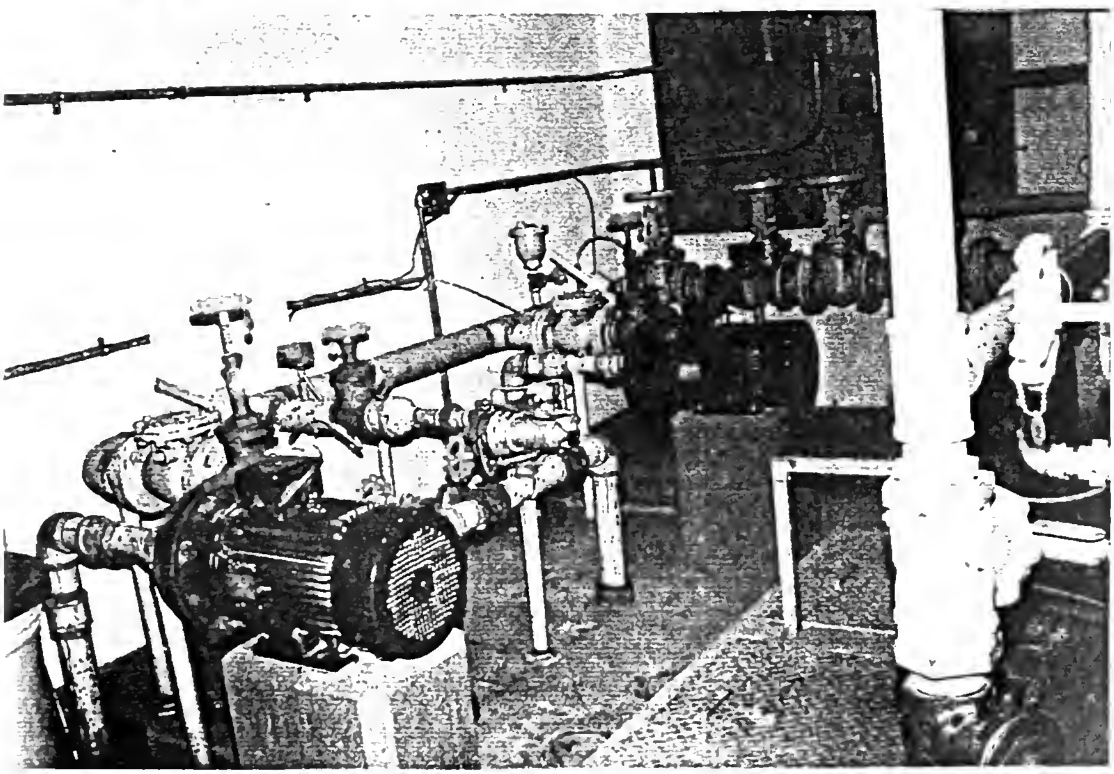


PHOTO NO. 6 - HIGH LIFT PUMPS AND PRESSURE RELIEF VALVE

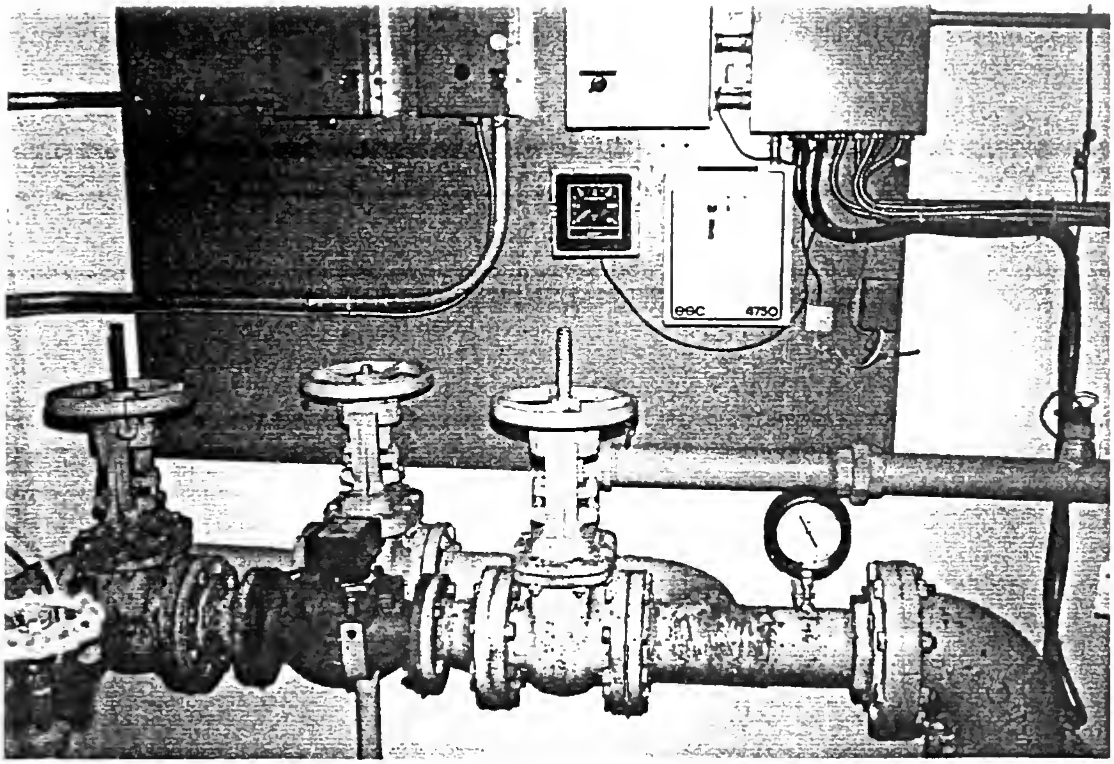


PHOTO NO. 7 - WATER METER

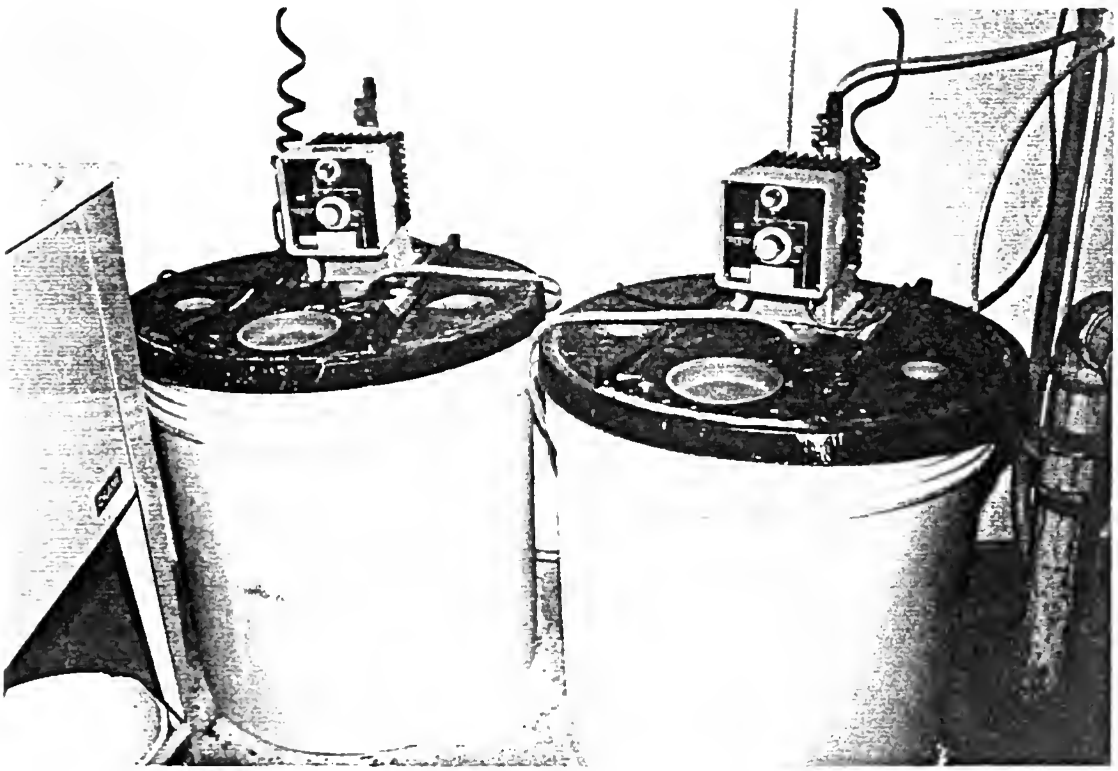


PHOTO NO. 8 - PRE AND POST CHLORINE SOLUTION TANKS
AND METERING PUMPS

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 3

WHITNEY-TISDALE WATER SUPPLY

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 3

WHITNEY-TISDALE WATER SUPPLY

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WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 3

WHITNEY-TISDALE WATER SUPPLY

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PHOTOGRAPHS

WATER PLANT OPTIMIZATION STUDY
CITY OF TIMMINS

PART 3

WHITNEY-TISDALE WATER SUPPLY

1.0 INTRODUCTION

This report constitutes the final volume of a three-part study. For a complete introduction and terms of reference, Part 1 should be consulted. It is reiterated here that on account of the proposed linking of the Whitney-Tisdale system with the Timmins system, the former will probably be relegated to the function of a standby system after 1988. This will completely change the present functions and mode of operation of the various components. For this reason, the level of effort spent on this volume has been reduced and the system description presented is not complete in every respect. Also, the three year performance data presented have been reduced to two months for each year, one representing summer and one representing winter operation.

The service area includes the districts of Whitney and Tisdale. Water is also supplied to the Preston area, Dome Mines and Dome Extension, who together consume approximately 10%. The presently serviced population is approximately 8000, of which about 2500 reside in Whitney and 5500 in Tisdale.

SECTION A - RAW WATER SOURCE

The Whitney and Tisdale systems were at one time separated and even now are linked only by one single main, as illustrated by Figure 1. The Whitney system is functioning as standby only and normally all water is supplied by the Tisdale system. The Tisdale system obtains its water from four wells situated in Shaw Township, at a distance of approximately 5 km south of the town. The wells supply water to a ground level water storage tank situated on high ground. Most of the time this tank supplies the Whitney-Tisdale distribution system by gravity via a single 450 mm

diameter, 4 km long transmission main. This gravity system maintains reasonable pressure in the distribution system during periods of normal demand. During high demand conditions, contacts on the flow meter activate one or more booster pumps to raise the pressure in the distribution system by approximately 100 kPa.

The acquifer in Shaw Township has been studied extensively. It has been found that suitable ground water supplies are limited to the previously established fields and that the natural recharge is insufficient to meet the demand. Water from outside the watershed must be relied upon extensively to augment it. To this purpose an older 300 mm diameter main of 5 km length was reactivated and water from Porcupine Lake is now supplied to a small dam centered in the recharge area. A separate chlorinator in the Tisdale pump house pre-chlorinates this water. However, the quality of the lake water is not high because the lake is almost surrounded by built-up areas and receives little inflow from the South Porcupine River and from Bob's Creek. Both are very small sources. The Dome Mine is also taking considerable quantities, so that the lake outlet is often dry or nearly dry, thus providing little dilution water to the sewage effluent from the treatment plant situated in Whitney. Industrial effluents from two mines are also discharged to the lake.

The condition of the wells requires regular attention and considerable maintenance is required to ensure their continued usage. Rehabilitation a few years ago of #1 and #2 wells improved the immediate pumping capacity somewhat, nevertheless well #4 was drilled in 1983 to make up for the decrease in output of #1 and #2. Well #1 has its own hypo-chlorinator to combat a taste and odour problem resulting from the presence of iron and manganese in the water. Occasional problems have been reported from colour or from nutrients in the recharge water. It is also predicted that after a few years of recharging, the soils will no longer remove the colour from the recharge water.

In addition, the water level in the acquifer must be monitored on a very regular basis by means of an extensive system of 23 observation wells. Because the recharge water quality leaves much to be desired, the recharge system is not used continuously and great care is taken to ensure that the acquifer does not become depleted. In order to have a water reserve available, should a high water demand of long duration occur (i.e. one or more water main breaks that cannot be immediately repaired) the Whitney well and reservoir system can be activated on short notice.

At the present time the Whitney system consists of one well, an underground storage tank and high lift pumps. The well is located near the northeast side of Bob's Lake. The Whitney acquifer also has limited capacity and in case of extended usage, recharging of the area can be accomplished via a separate pump and and intake from Bob's Lake. However, the recharge water is of poor quality because of the extensive urban development around Bob's Lake.

It is to be expected that the linking with the Timmins system will eliminate the five pumps and two engines in the Whitney system, as well as the recharge requirements for the Tisdale acquifer, and that the remaining Tisdale supply system be designated as standby.

The two systems are presented as a diagram on Figure 2.

SECTION B - FLOWS AND FLOW MEASUREMENT

The Tisdale system is equipped with a magnetic flow meter on the main supplying the distribution system. However, the meter is considered to be inaccurate at low to normal flows and the integrator readings are not used to record flows. Instead, the water meters on each of the wells which are in service are read every second day and the individual readings are added up and used as flow records. These values are consequently shown in the attached tables. The function of the magnetic flow meter is to sense abnormally high flows in order to activate one or more

booster pumps, since high flows in the transmission main will cause unacceptably low pressures in the distribution system.

In the Whitney system a meter on the supply pipe of the well pump, located in the reservoir and high lift station, records the water produced.

The demands of the Whitney-Tisdale system have been found to be very constant. There is believed to be considerable leakage in the underground distribution system, causing a very constant base load of near 45% of total production (Gore & Storrie Limited, Study on Water Needs for the City of Timmins, June 1982). Consequently, peak demands of 1.3 to 1.6 times average are much smaller than for comparable small communities. On the basis of six months of records, divided over three years, the per capita demand is 0.57 m^3/d.

SECTION C - PROCESS COMPONENTS

C:1 Tisdale

Well No. 1: constructed in 1948, consists of a 350 mm casing to a depth of 11.6 m, followed by a 3.0 m long screen. A 500 mm outer casing extends to 10.0 m. The well is equipped with a 250 mm, 22.5 kW Layne vertical turbine of 37.9 L/s capacity. The continuously pumped well was rated at 18.2 L/s (1572 m^3/d). The pump house for Well No. 1 contains a hypochlorinator that injects chlorine in the well whenever the pump is running, at a rate to produce 0.5 mg/L. The chlorine solution is made by dissolving 70% HTH powder. A small emergency generator ensures continued chlorination. Pump and discharge piping are shown on photographs #7 and #8.

Well No. 2: constructed in 1953, consists of a 300 mm casing to a depth of 14.4 m and a 3.0 m long screen. The outer casing is 650 mm. The pump is a Layne 10 KHC vertical turbine with 22.5 kW motor rated at 37.9 L/s. The continuously pumped well capacity is 18.9 L/s (1634 m^3/d).

Well No. 3: was constructed in 1975. It consists of 17.2 m long, 300 mm casing, followed by a 6.5 m screen. The outer casing is 600 mm and extends to 16.0 m. The pump is a Layne vertical turbine rated at 60.6 L/s with dual 37.5 kW motor and Dorman 4A engine. The well was rated at 37.8 L/s (3268 m^3/d).

Well No. 4: constructed in 1983, consists of a 250 mm inner casing of 12.9 m depth and a 5.5 m long screen, surrounded by a 500 mm outer casing to 12.0 m depth. The pump is a Berkeley submersible pump of 18 kW with a capacity of 34 L/s. The well was tested to produce 13.7 L/s (1184 m^3/d).

The four pumps are connected via a common header to an in-ground concrete water storage tank of 6800 m^3 capacity. Adjacent to the tank is a pumping station containing booster pumps and chlorination facilities, as illustrated on photographs #1 and #2. Normal operation consists of supplying water to the distribution system by gravity which results in moderate pressures in the distribution system. Pressures during high demand are insufficient.

The three booster pumps are of the vertical turbine type, with the first stage bowl connected via a 90° elbow to the 500 mm discharge pipe from the reservoir. All three pumps are Berkeley 2 stage, 1403H vertical turbine. The two electric units are equipped with dual speed, 1200/1800 rpm electric motors of 56 kW and rated at 6817 m^3/d (78.9 L/s) @ 13.4 m TDH. They are activated automatically by contacts on the magnetic flow meter and start in sequence when demands exceed certain set points. The third unit is driven by a diesel motor of 1800 rpm via a right angle gear drive. Photographs #3 and #4 show the three pump motors and pumps.

Chlorination for system water is done by means of two (one duty, one standby) Wallace & Tiernen 91-100 wall mounted gas chlorinators. An identical third unit is in service to provide chlorine at a rate of 0.2 to 0.3 mg/L to the recharge water for

the acquifer. Two weigh scales, each suitable for 2 - 67 kg gas cylinders are connected to the duty chlorinators. There is no flow pacing and all chlorine dosage rates are set manually. This is considered acceptable because the distribution system demands are very constant due to high leakage. Chlorine solution is injected by small booster pumps into the main leaving the reservoir, as shown on photograph #5.

Controls: The well pumps can be automatically controlled by level in the storage tank. Booster pumps #1 and #2 are governed by system demand. In addition, there is telemetry to the Timmins Water Treatment Plant for the following functions:

* Continuous indication and recording of reservoir level and magnetic flow meter.
* Chlorine leakage alarm.
* Booster pumps #1 and #2, manual/auto stop/start controls.
* Wells #1, #2 and #3, manual/auto stop/start.

All chlorinator feed rates are set manually from time to time.

C:2 Whitney

The well has a 400 mm inner casing to a depth of 9.0 m, followed by a 4.6 m long well screen. The outer casing is 630 mm and 9.0 m deep. The pump is a 150 mm diameter Berkeley #6S2AM5 submersible unit, 15 L/s, with 11 kW motor. The rated capacity is 1036 m^3/d (15 L/s) @ 61.0 m TDH. A manual start diesel generator is available to drive the pump.

The concrete ground level reservoir is located approximately 1.0 km from the well, on Bob's Lake. It has a storage capacity of 450 m^3. A pump house (photograph #9) over the reservoir contains two electric (photograph #11) and one diesel driven pump.

* Pumps #1 and #2: Hayward Gordon, close coupled, end suction type, each rated 653 m^3/d (7.6 L/s) @ 30 m TDH.
* Pump #3: Allis Chalmers, engine driven, rated 3260 m^3/d (37 L/s).

The two electric pumps are controlled by system pressure.

A gas chlorinator, Wallace & Tiernen V-100, complete with a weigh scale for two 67 kg cylinders is activated simultaneously with the well pump. Chlorine solution is added to the reservoir.

Because the reservoir and pump system is inactive most of the time, a small flow of about 0.5 L/s is continuously fed from the distribution system back into the reservoir and out to waste. This ensures that the tank will always be full and that the water will not be too stale.

SECTION D - PLANT OPERATION

D:1 Operation

The Tisdale system and, when operating, also the Whitney system, is visited three times per week. Records are kept of the water levels in each well, the hours pumped by each pump, the discharge pressure and the volume produced from each well. On a weekly basis, the static level in each well is recorded two hours after a pump is stopped and the static level is also measured in 23 observation wells.

At the main pump house, a record is made during every visit of weight of chlorine used, the reservoir level and the hours on each booster pump.

The Whitney system, when operational, is operated in a similar manner.

On a monthly basis, samples are collected from all four wells, the reservoir, recharge water and two points in the distribution system, and sent to the Ministry laboratory in Toronto. The results of these analyses are presented in Table No. 4.

During the visits water samples are collected from #1 well, the reservoir and a point in the distribution system. These are brought back to the water treatment plant and analyzed for:

* Turbidity
* Colour
* pH

The samples are analyzed locally for free chlorine, and chlorine dosages are manually adjusted to maintain 0.5 mg/L free chlorine residual in the system water.

Bacteriological test samples have not been collected on a regular basis. By examining the records of the Porcupine Health Unit, it was found that regular sampling was done by the Cochrane-Timmins Resource Centre. The results are reproduced in Table 6.1. Waterworks personnel have, since February, 1987, introduced their own sampling program at the following points: Reservoir, Municipal Workshops in Whitney and Tisdale, and various other points in the distribution system. On average, 5 samples per week are collected. Test results are summarized in Table 6.0.

D:2 Validity of Data Collected

The accuracy of the flow meters can only be verified by volumetric fill or draw tests on the reservoirs. This is a very time consuming and therefore expensive method that was considered to be outside the scope of this report. The individual meters on the well pumps are all of the mechanical type and therefore considered to be reasonably accurate. It is reported that the individual meter readings have been compared with the results of a portable clamp-on type Doppler meter, with favourable results. The magnetic flow meter, which is reportedly inaccurate at low flows, is used only to control the booster pumps and its totallizer readings are not reported.

Chemical analyses as performed by the Ministry of the Environment laboratory in Toronto, have been compared with results of tests done at the Water Treatment Plant and found to be very consistent.

Chlorine consumption, as obtained by weighing the gas cylinders, is considered reliable.

SECTION E - PLANT PERFORMANCE

E:1 Particulate Removal

This subject does not apply.

E:2 Disinfection

The disinfection summary, Table No. 2.0, illustrates that despite consistent chlorine applications of near 1.1 mg/L, the average residual chlorine values are in the order of 0.1 mg/L. The bacteriological testing results have been good as illustrated in Table 6.0 and 6.1. However, background bacteria have been found in 16 out of 206 samples.

SECTION F - POSSIBLE SHORT AND LONG TERM MODIFICATIONS

F:1 Short Term Modifications

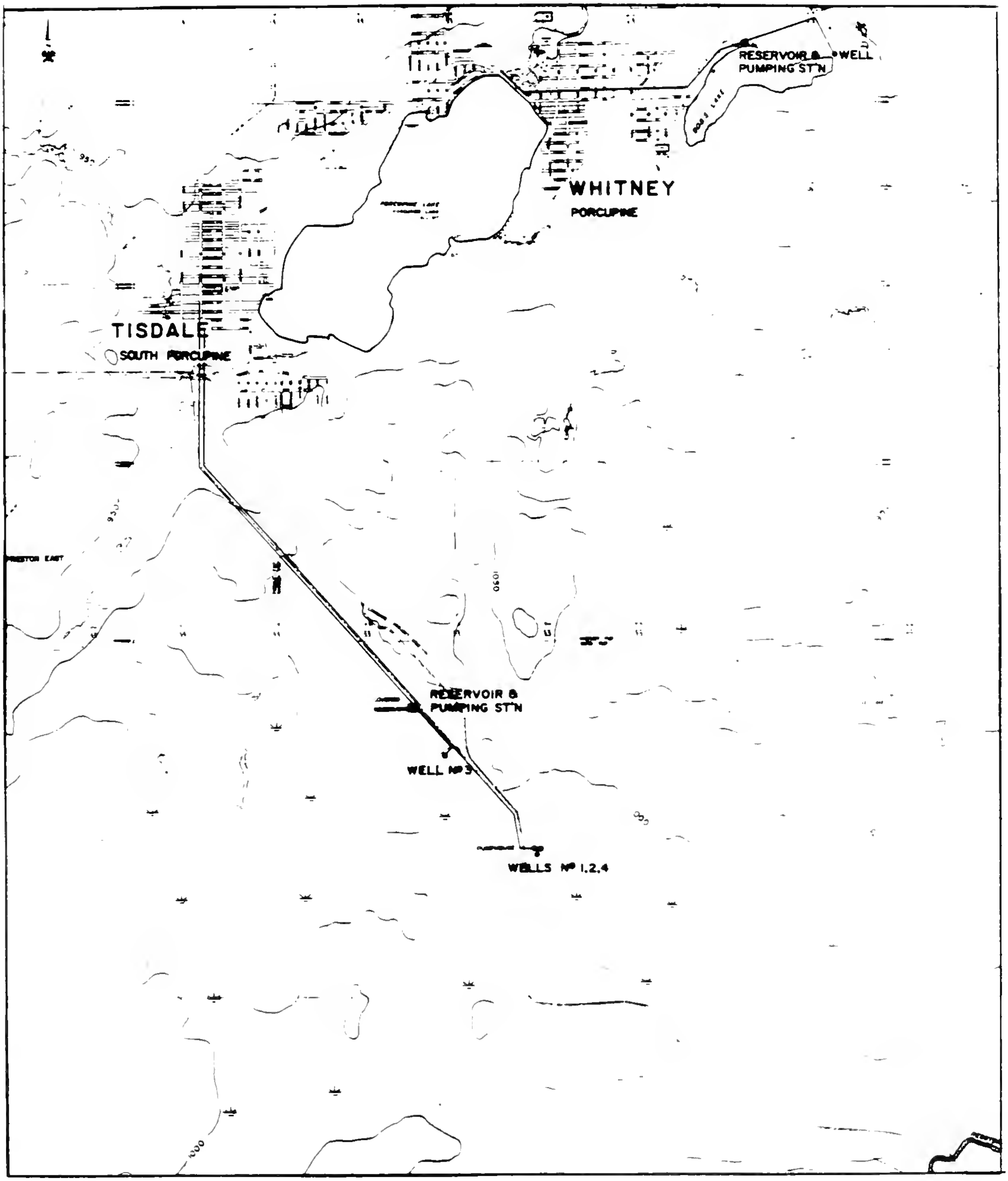
Increased chlorine dosages are recommended. An automatic continuously recording chlorine analyzer could be considered.

F:2 Long Term Modifications

The effect of the linking up of the Timmins supply to the Whitney reservoir should be carefully monitored. It may be necessary to rechlorinate the supply on account of the long transit period. In

that case continuous analyzing and automatic adjustment of the rechlorination dosage might be required.

The decommissioning and "mothballing" of some components of the present system and the exercising of essential equipment required for standby should be studied in detail.

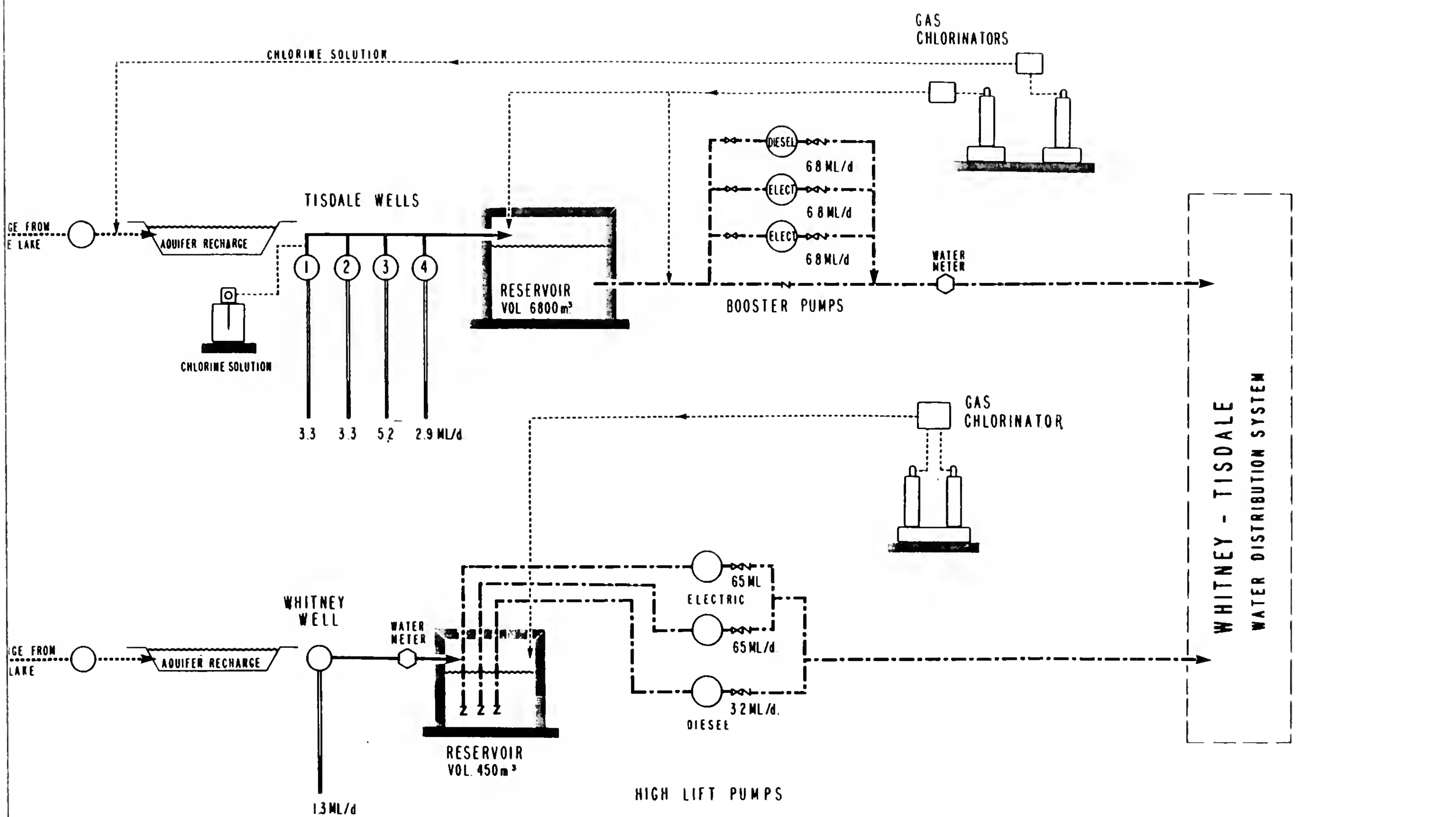


WHITNEY - TISDALE

SITE PLAN

SCALE 1 : 50 000

Fig. I



WHITNEY - TISDALE
PROCESS & PIPING
DIAGRAM

Fig.2

WHITNEY-TISDALE

TABLE NO. 1.0: DAILY FLOWS (ML/d) JANUARY AND JUNE - 1984, 1985, 1986

DAY	1984		1985		1986	
	JANUARY	JUNE	JANUARY	JUNE	JANUARY	JUNE
1		4.764		4.741		
2						16.052
3			13.738	9.324	12.652	
4	19.507	13.897	4.364			8.065
5	3.969	4.760		4.591		
6	3.837	4.551		4.664	13.752	9.324
7		5.232	12.979	5.078	5.655	
8		4.932			4.801	
9	11.938		8.628			12.865
10	3.837		4.410	17.279	9.838	
11	4.155	15.361	4.360	4.778		
12	4.100	4.896		9.406		15.297
13	4.378	3.900		4.269	15.102	4.182
14			13.838		4.501	
15		7.196	6.096		5.296	
16	12.892		3.710		5.169	12.770
17			4.273	10.856	4.901	
18	9.251	10.656	4.341	6.260		8.915
19	4.041	4.305		4.982		
20	4.432	4.632		4.755	14.261	9.033
21		3.309	13.624	4.787		
22		3.900			9.992	
23	12.829		8.683			11.156
24	4.501			13.915	10.615	
25		14.897	8.469			9.433
26	8.619	4.855		9.538		
27	4.505	4.278		4.305	14.988	8.556
28		3.650	11.170	4.928		
29		3.510			10.919	
30	17.475		7.569			12.047
31			4.460		10.783	
TOTAL	134.266	127.481	134.712	128.456	153.225	137.695
AVG.	4.476	4.396	4.346	4.588	4.943	4.590

NOTE: Flows shown are quantities read after intervals of 1, 2, 3 or 4 days.

Source: Plant records

WHITNEY-TISDALE

TABLE NO. 1.1: PER CAPITA CONSUMPTION (L/D/CAP)

Population: 8000

Average Day: 570 L/D/cap

WHITNEY-TISDALE

TABLE NO. 2.0: PARTICULATE REMOVAL SUMMARY 1984

	JANUARY						JUNE					
	pH		COLOUR		TURBIDITY		pH		COLOUR		TURBIDITY	
	R	T	R	T	R	T	R	T	R	T	R	T
1												
2												
3							7.2	7.4	10	7	0	0
4	7.1	7.1	5	10	0.3	0.6	7.4	7.3	5	5	0	0
5	7.2	7.3	20	15	0.5	0.5	7.7	7.3	12	7	0	0
6							7.7	7.4	12	5	0	0
7												
8												
9	7.1	7.6	5	20	0.5	0.6	7.2	7.2	5	5		
10	7.4	7.5	10	5	0.4		7.2	7.2	5	5		
11	7.4	7.4	10	15	0.4	0.6	7.2	7.2	5	5		
12	7.5	7.4	10	15	0.4	0.5	7.2	7.2	5	5		
13							7.2	7.2	5	5		
14												
15												
16	7.4	7.5	15	5	0.7	0.5	7.6	7.5	5	2		
17												
18	7.1	7.1	5	5	0.5	0.7						
19	7.3	7.3	5	5	0.7	0.6	7.4	7.6	5		0.2	0.2
20	7.2	7.4	5	5	0.4	0.4	7.1	7.1	5	5	0.5	0.7
21												
22												
23	7.5	7.5	5	5	0.6	0.5						
24	7.1	7.1	5	5	0.8	0.7	7.5	7.5	5	5	0.2	0.3
25												
26	7.1	7.1	5	5	1.0	0.7						
27	7.1	7.1	5	5	0.6	0.8						
28												
29												
30							7.4	7.8	5	3	0.3	0.4
31							7.2	7.2	5	5	0.4	0.5

NOTE: All testing performed at Timmins Water Treatment Plant

Source: Plant records

WHITNEY-TISDALE

TABLE NO. 2.0: PARTICULATE REMOVAL SUMMARY 1985

	JANUARY						JUNE					
	pH		COLOUR		TURBIDITY		pH		COLOUR		TURBIDITY	
	R	T	R	T	R	T	R	T	R	T	R	T
1												
2												
3	7.3	7.4	5	5	0.3	1.0	7.4	7.3	0.1	0.5	0.7	0.5
4	7.4	7.1	5	5	0.3	0.8	7.1	7.1	5	5	0.8	0.6
5							7.0	7.0	5	5	0.5	0.5
6												
7	7.4	7.5	7	5	0.6	1.0						
8							7.1	7.1	5	5	0.4	0.4
9	7.0	7.5	7	3	1.0	1.4						
10												
11	7.2	7.6	10	5	0.9	0.8	7.6	7.1	10	15	0.5	2.0
12							7.2	7.2	10	5	0.3	0.7
13												
14	7.3	7.4	5	5	0.6	0.5						
15	7.6	7.5	5	5	0.7	0.6	7.3	7.4	10	5	0.3	0.5
16	7.4	7.3	5	5	0.7	1.0						
17	7.1	7.1	5	5	1.3	1.3	7.1	7.3	17	7	0.3	0.2
18	7.1	7.1	5	5	1.5	1.1						
19							7.3	7.1	17	7	0.3	0.4
20												
21	7.1	7.1	5	5	0.5	1.2						
22							7.0	7.1	5	15	0.3	0.7
23	7.2	7.2	5	5	0.6	0.9						
24							7.4	7.3	10	7	0.9	0.8
25	7.3	7.3	5	5	0.3	0.8						
26							7.3	7.4	5	5	0.6	0.7
27												
28	7.3	7.3	5	5	0.4	2.7						
29							7.1	7.1	5	5	0.8	0.9
30	7.4	7.1	7	3	0.4	1.0	7.5	7.1	5	5	0.7	0.6
31	7.2	7.3	7	3	0.5	1.0	7.1	7.1	5	5	0.5	0.8

NOTE: All testing performed at Timmins Water Treatment Plant.

Source: Plant records

WHITNEY-TISDALE

TABLE NO. 2.0: PARTICULATE REMOVAL SUMMARY 1986

	JANUARY						JUNE					
	pH		COLOUR		TURBIDITY		pH		COLOUR		TURBIDITY	
	R	T	R	T	R	T	R	T	R	T	R	T
1												
2							7.5	7.5	20	10	0.3	0.5
3	7.2	7.2			0.1	0.3						
4							7.4	7.2	15	10	0.7	0.6
5												
6	7.3	7.4			0.2	0.2						
7	7.4	7.6			0.2	0.2	7.5	7.4	30	15	0.4	0.6
8	7.4	7.5			0.2	0.3						
9							7.4	7.4	25	10	0.3	0.6
10	7.4	7.4			0.1	0.3						
11							7.3	7.5	15	7	0.2	0.6
12												
13	7.1	7.5			1.9	0.2						
14	7.4	7.4			0.2	0.2						
15												
16							7.4	7.3	30	15	0.2	0.3
17	7.4	7.4	8	5	0.2	0.4						
18							7.4	7.4	5	5	0.3	0.3
19												
20	7.3	7.3	5	5	0.1	0.4						
21	7.4	7.4	5	5	0.3	0.2	7.4	7.3	5	5	0.3	0.4
22												
23							7.5	7.6	30	15	0.2	0.4
24	7.4	7.4	5	5	0.2	0.2						
25							7.3	7.5	20	15	0.3	0.1
26												
27	7.4	7.4	5	5	0.1	0.1						
28							7.4	7.5	30	20	0.4	1.1
29	7.4	7.4	5	5	0.1	0.1						
30							7.5	7.4	10	10	0.4	0.6
31	7.4	7.4	5	5	0.1	0.2						

NOTE: All testing performed at Timmins Water Treatment Plant.

Source: Plant records

WHITNEY-TISDALE

TABLE NO. 3.0: DISINFECTION SUMMARY (mg/L)

	1984				1985				1986			
	JANUARY		JUNE		JANUARY		JUNE		JANUARY		JUNE	
	Dosage	Free Chlor	Dosage	Free Chlor	Dosage	Free Chlor	Dosage	Free Chlor	Dosage	Free Chlor	Dosage	Free Chlor
1			1.43				0.96					
2											0.85	0.15
3				0.0	0.99	0.0	0.73	0.0	1.37	0.0		
4	0.98	0.0	0.82	0.1	0.52	0.15		0.0			1.13	0.0
5	0.80	0.0	1.43	0.0			0.99	0.2				
6	1.54		0.80	0.0			2.44		0.60	0.0	1.22	
7			0.96		0.88	0.1	1.07		1.21	0.0		0.0
8			0.65					0.1	0.95	0.0		
9	1.07	0.15		0.2	0.95	0.0					1.06	0.0
10	1.07	0.0		0.0	1.03		0.66		1.16	0.0		
11	1.09	0.15	1.04	0.2	0.73	0.0	1.24	0.0				0.0
12	1.11	0.1	0.93	0.2			1.16	0.0			1.01	
13	0.83		1.17	0.2			1.38		1.21	0.1	1.09	
14					0.99	0.0			1.52	0.0		
15			1.26		0.75	0.0		0.1	1.03			
16	1.73	0.2		0.0	1.23	0.05			1.41		1.07	
17					1.06	0.3	1.55	0.0	1.11	0.2		
18	0.98	0.1	1.28		1.05	0.3	0.94				1.12	0.35
19	1.01	0.1	1.06	0.2			1.19	0.0				
20	1.13	0.0	0.98	0.2			0.76		1.21	0.15	1.16	
21			1.37		0.83	0.3	1.23			0.0		0.0
22			1.17					0.0	1.00			
23	1.31	0.0			0.79	0.2					1.43	0.15
24	1.52	0.3					1.14	0.0	1.80	0.0		
25			1.07		1.07	0.0					0.96	0.15
26	1.05	0.0	0.94				1.00	0.0				
27	1.01	0.4	1.06				1.16		1.22	0.0	0.53	
28			1.49		1.02	0.8	1.20					0.15
29			2.68					0.2	0.92	0.0		
30	0.78				1.80	0.1		0.3			0.57	0.15
31					1.02	0.1		0.2	0.38	0.0		
AVG.	1.11	0.11	1.09	0.11	0.98	0.15	1.10	0.07	1.11	0.03	1.00	0.10

NOTE: Free chlorine residual 0.0 means residual is not measurable by DPD method.

Source: Plant records

WHITNEY-TISDALE

BLE NO. 4.0: WATER QUALITY FOR 1984, 1985 AND 1986

	1984				1985				1986			
	JANUARY		JUNE		JANUARY		JUNE		JANUARY		JUNE	
	R	T	R	T	R	T	R	T	R	T	R	T
Conductivity UMHO/cm	340.	339.	310.	311.	459.	470.	368.	369.	456.	452.	347.	335.
Hardness mg/L	180.	178.	157.	159.	230.	227.	179.	179.	231.	227.	163.	155.
Calcium mg/L	55.0	54.0	47.0	48.0	70.0	69.0	54.0	54.0	70.0	68.0	48.9	46.2
Magnesium mg/L	10.4	10.5	9.6	9.4	13.3	13.4	10.7	10.8	13.7	14.0	9.85	9.45
Sodium mg/L	1.5	1.5	3.0	2.8	6.7	10.7	5.6	6.2	8.0	8.0	6.0	6.0
Potassium mg/L	.90	.95	1.25	1.25	1.50	15.0	1.35	1.35	1.55	1.40	1.57	1.48
Alkalinity mg/L	149.	149.	129.	131.	150.	152.	133.	134.	152.	150.	132.	127.
pH	8.04	8.00	7.63	7.64	7.70	7.76	7.65	7.64	7.52	7.53	8.13	8.13
Fluoride mg/L	.05	.05	—	—	.04	.06	.06	.07	.06	.05	.06	.07
Chloride mg/L	2.2	2.6	4.6	6.0	11.6	11.4	8.6	8.2	11.8	12.0	8.15	8.0
Sulphate mg/L	24.0	24.0	28.0	28.0	69.0	73.0	54.0	54.5	75.0	74.0	36.6	35.4
Phosphorus mg/L	.01T	.06T	.01W	.02W	.01W	.01W	.04T	.04T	.01W	.01W	.02W	.02W
Nitrogen mg/L	.2T	.2T	.2T	.2T	.4	.3T	.3T	.3T	.2T	.2T	.2T	.4T
Ammonium mg/L	.1W	.1W	.05W	.05W	.05W	.1T	.05W	.05W	.05W	.05W	.05W	.05W
Nitrates mg/L	.1T	.1T	.05W	.05W	.2	.2	.2T	.2T	.2T	.2T	.05T	.05T
Iron mg/L	.02T	.08	.05	.32	.25	.28	.014	.047	NSS	NSS	.002	.080
Manganese mg/L	.080	.010	.050	.020	.145	.082	.023	.018	NSS	NSS	.050	.010

te: All testing performed by MOE Laboratory, Toronto.

T - This measurement is tentative - for information only.
W - Value reported is minimum measurable amount.

urce: MOE Laboratory, Toronto

WHITNEY-TISDALE

TABLE 5.0: ALGAE COUNT

MONTH	COUNT				
January	Max. Min. Avg. No. Tests				
February	Max. Min. Avg. No. Tests				
March	Max. Min. Avg. No. Tests				
April	Max. Min. Avg. No. Tests				
May	Max. Min. Avg. No. Tests				
June	Max. Min. Avg. No. Tests				
July	Max. Min. Avg. No. Tests				
August	Max. Min. Avg. No. Tests				
September	Max. Min. Avg. No. Tests				
October	Max. Min. Avg. No. Tests				
November	Max. Min. Avg. No. Tests				
December	Max. Min. Avg. No. Tests				

NOTE: No data on particulate counting, suspended solids or algae counts is available.

WHITNEY-TISDALE

TABLE 6.0: BACTERIOLOGICAL TESTING 1987

MONTH	R/T	TOTAL COLIFORM					FECAL COLIFORM					FECAL STREPTOCOCCUS			
		ABSENT	1-5	6-100	101-5000	5000	ABSENT	1-5	6-10	11-500	500	ABSENT	1	2-50	50
JAN	R														
	T														
FEB	R														
	T		--	--	--	--		--	--	--	--				
MAR	R														
	T	19	1	--	--	--	19	1	--	--	--				
APR	R														
	T	20	--	--	--	--	20	--	--	--	--				
MAY	R														
	T	19	--	--	--	--	19	--	--	--	--				
JUN	R														
	T	21	--	--	--	--	21	--	--	--	--				
JUL	R														
	T	19	--	--	--	--	19	--	--	--	--				
AUG	R														
	T	19	--	--	--	--	19	--	--	--	--				
SEP	R														
	T	21	--	--	--	--	21	--	--	--	--				
OCT	R														
	T	17	--	--	--	--	17	--	--	--	--				
NOV	R														
	T	18	--	--	--	--	18	--	--	--	--				
DEC	R														
	T	21	--	--	--	--	21	--	--	--	--				

NOTE: All results are for 100 mL samples. Tests carried out at MOE lab, Timmins. No analysis performed for Fecal Streptococcus.

R = Raw; T = Treated

Source: Public Health Laboratory, Timmins

WHITNEY-TISDALE

TABLE NO. 6.1: BACTERIOLOGICAL TESTING - 1984, 1985 AND 1986 (SYSTEM WATER)

MONTH	1984	1985	1986
JANUARY	0-0	0-0	0-0
FEBRUARY	0-0	0-0	0-0
MARCH	0-0	0-0	0-0
APRIL	0-0	0-0	0-0
MAY	0-0	0-0	0-0
JUNE	0-0	0-0	0-0
JULY	0-0	0-0	0-0
AUGUST	0-0	0-0	0-0
SEPTEMBER	0-0	0-0	0-0
OCTOBER	0-0	0-0	0-0
NOVEMBER	0-0	0-0	0-0
DECEMBER	0-0	0-0	0-0

SAMPLING SITE: Cochrane-Timmins Resource Centre

First value denotes Total Coliform in 50 mL/sample
Second value denotes Fecal Coliform in 50 mL/sample

Source: Public Health Laboratory, Timmins

WHITNEY-TISDALE

TABLE 7.0: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY INCLUDING ALUMINUM (TREATED WATER AT PLANT)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT
Jan. 9, 1985	Turbidity	1.4 FTU	1.0 FTU
Jan. 17, 1985	Turbidity	1.3 FTU	1.0 FTU
Jan. 18, 1985	Turbidity	1.1 FTU	1.0 FTU
Jan. 21, 1985	Turbidity	1.2 FTU	1.0 FTU
Jan. 28, 1985	Turbidity	2.7 FTU	1.0 FTU
June 11, 1985	Turbidity	2.0 FTU	1.0 FTU
June 28, 1986	Turbidity	1.1 FTU	1.0 FTU

Source: Plant records

WHITNEY-TISDALE

TABLE 7.1: ONTARIO DRINKING WATER OBJECTIVES EXCEEDANCE SUMMARY (DISTRIBUTION SYSTEM)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT

NOTE: No data from the distribution system are available.

PHOTO NO. 1 - TISDALE
GROUND LEVEL RESERVOIR IN BACKGROUND
PUMPING STATION IN FOREGROUND

PHOTO NO. 2 - TISDALE
GROUND LEVEL RESERVOIR

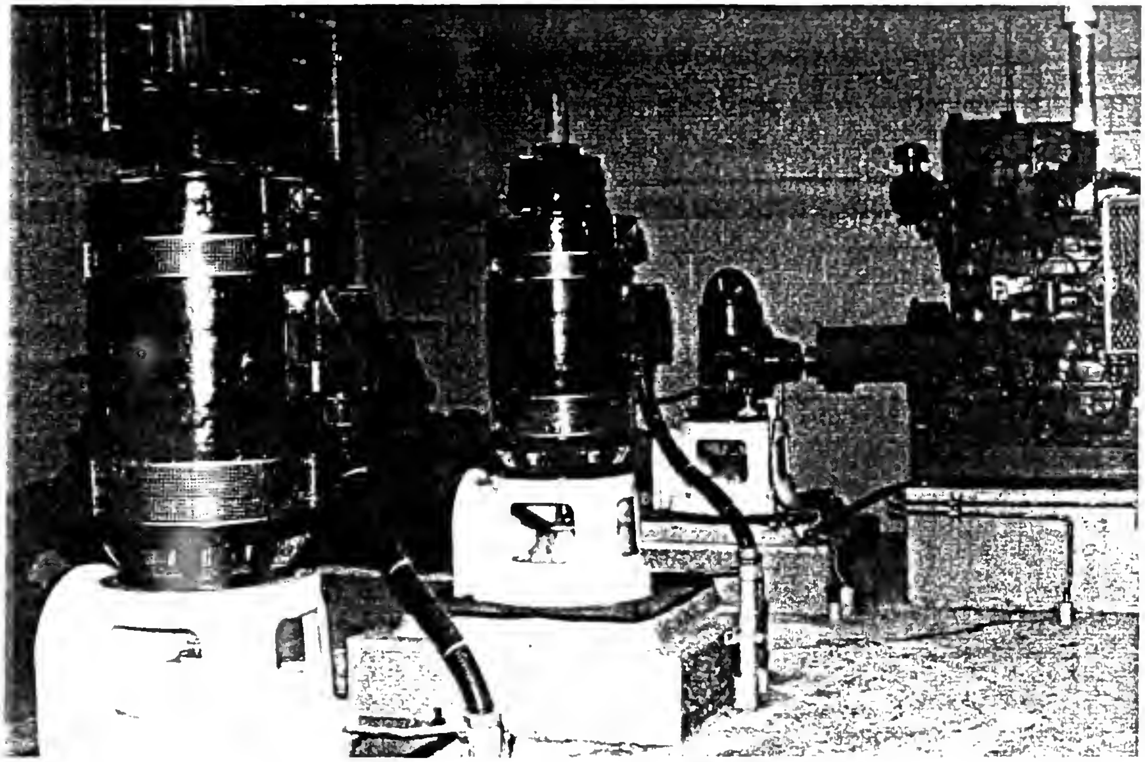


PHOTO NO. 3 - TISDALE
3 BOOSTER PUMPS

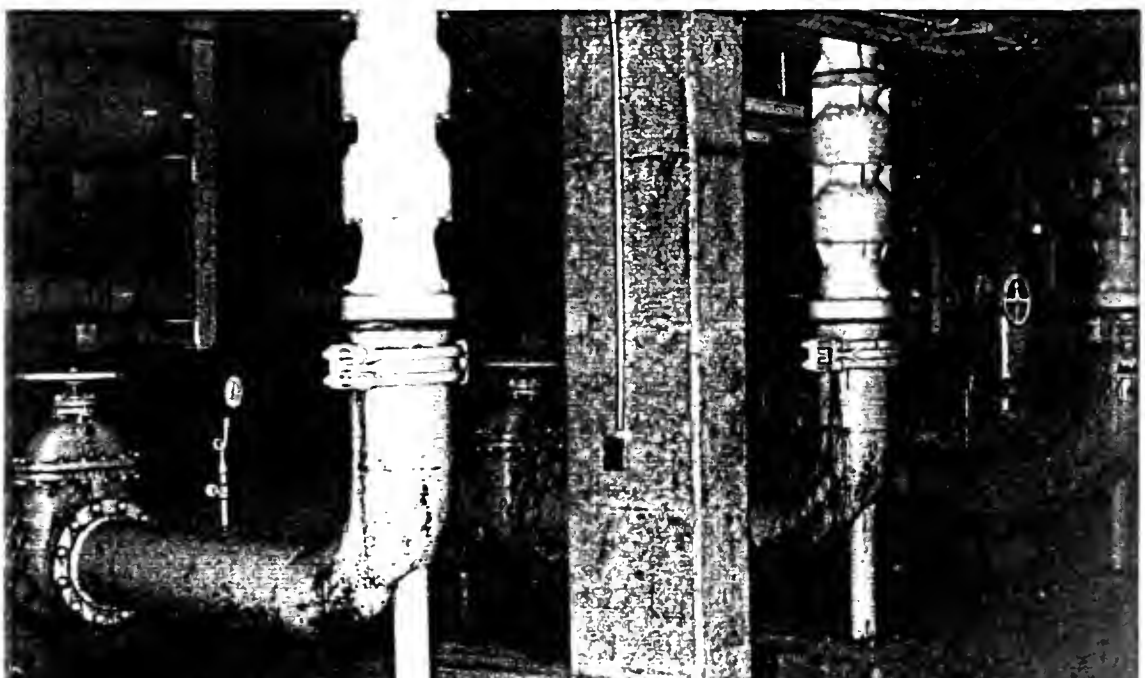


PHOTO NO. 4 - TISDALE
3 BOOSTER PUMP SUCTIONS

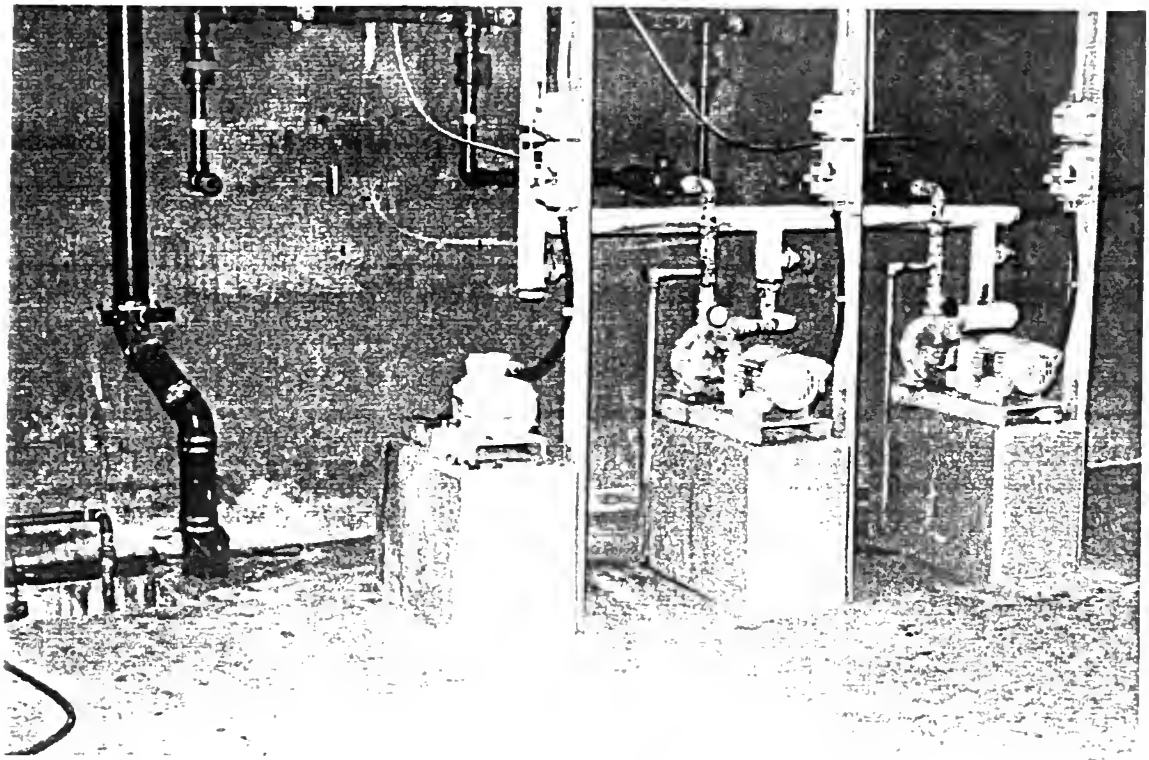


PHOTO NO. 5 - TISDALE
CHLORINATOR WATER SUPPLY PUMPS

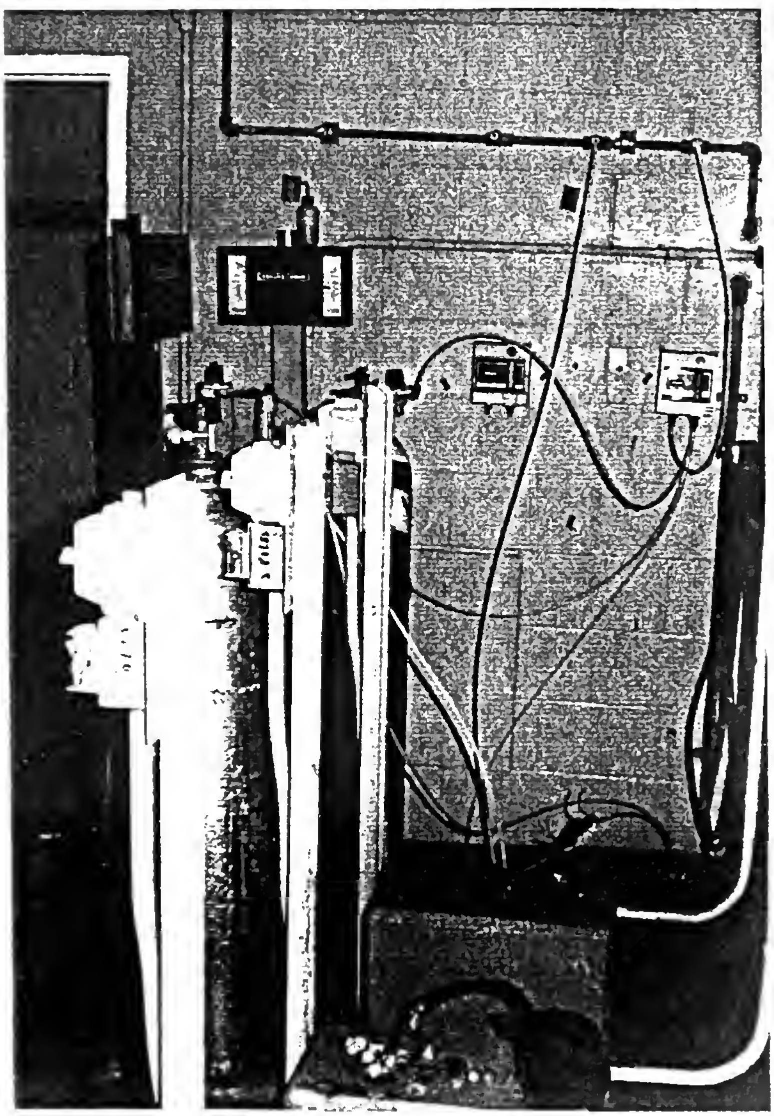


PHOTO NO. 6

TISDALE
CHLORINATORS

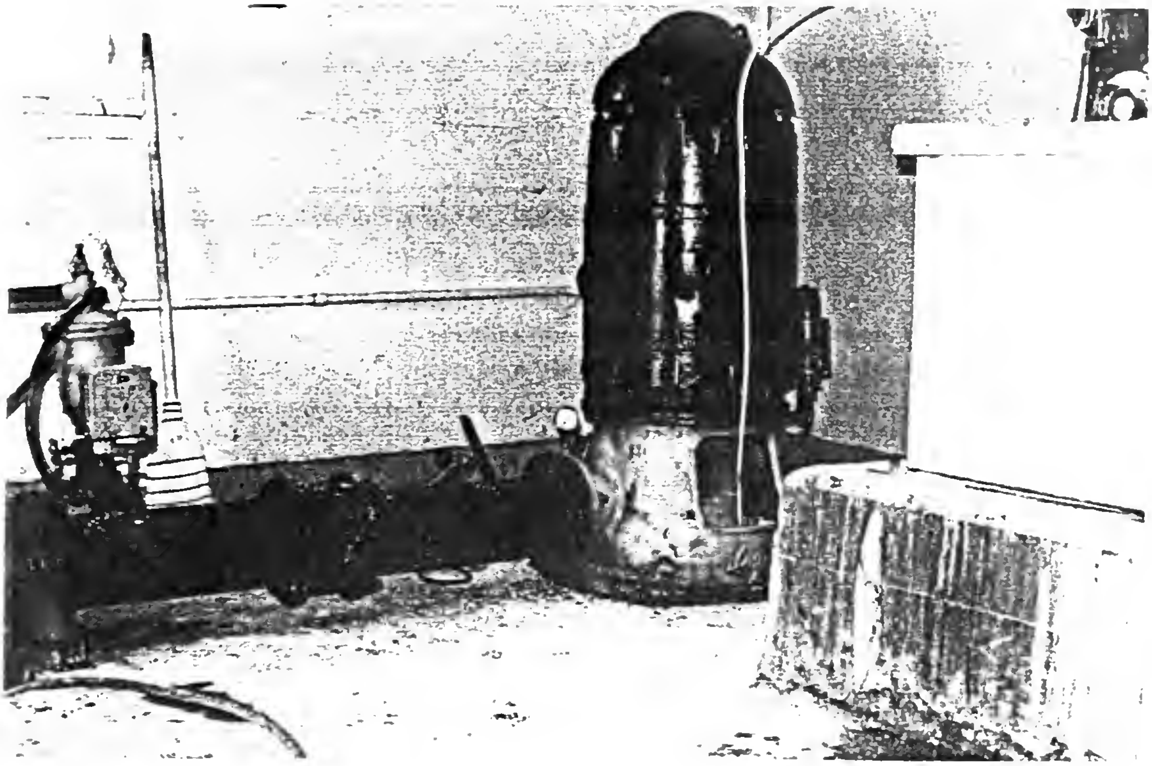


PHOTO NO. 7 - TISDALE
WELL NO. 1
CHLORINE SOLUTION TANK METERING PUMP AND VERTICAL TURBINE

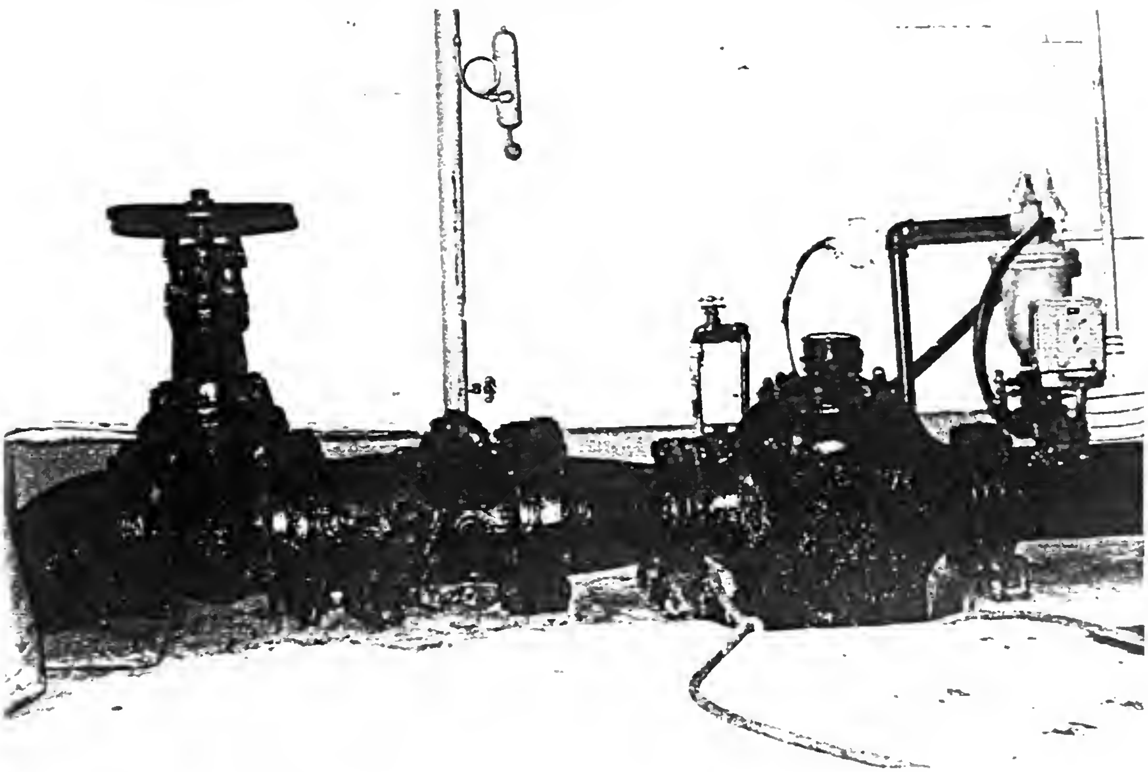


PHOTO NO. 8 - TISDALE
WELL NO. 1

PHOTO NO. 9 - WHITNEY
BOB'S LAKE PUMPING STATION
CONSTRUCTED OVER RESERVOIR

PHOTO NO. 10

WHITNEY

WATER METER ON
WELL PUMP
DISCHARGE

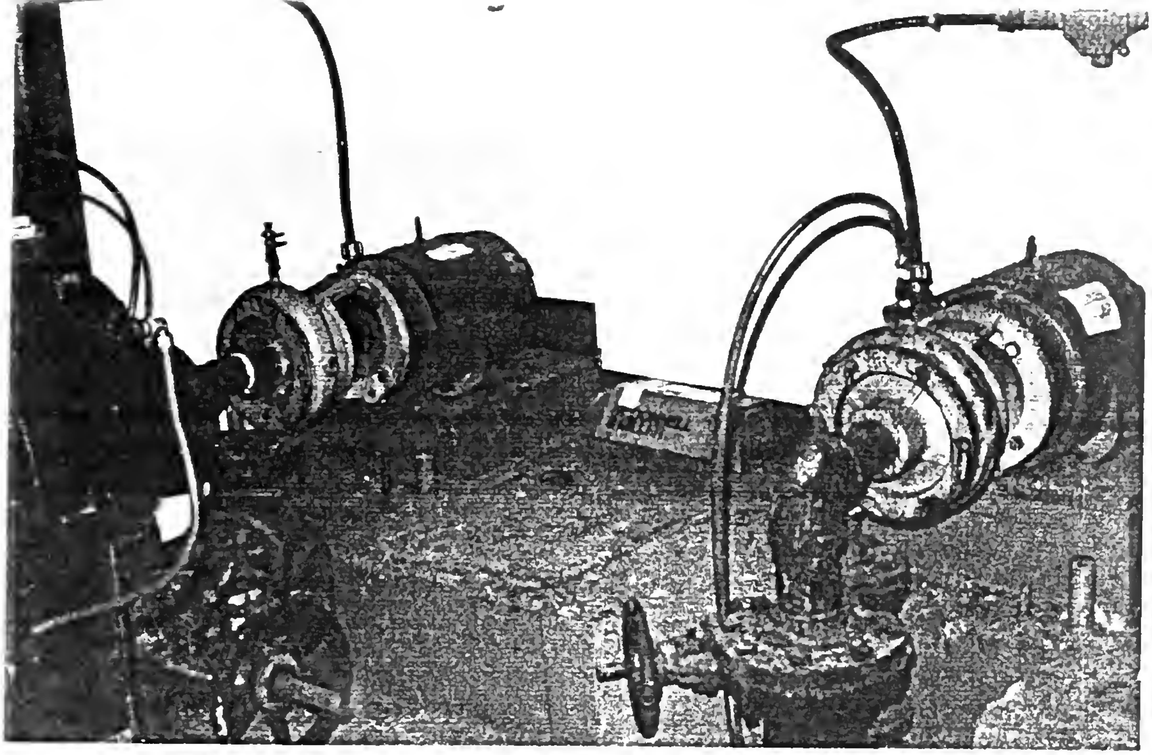


PHOTO NO. 11 - WHITNEY
2 HIGH LIFT PUMPS

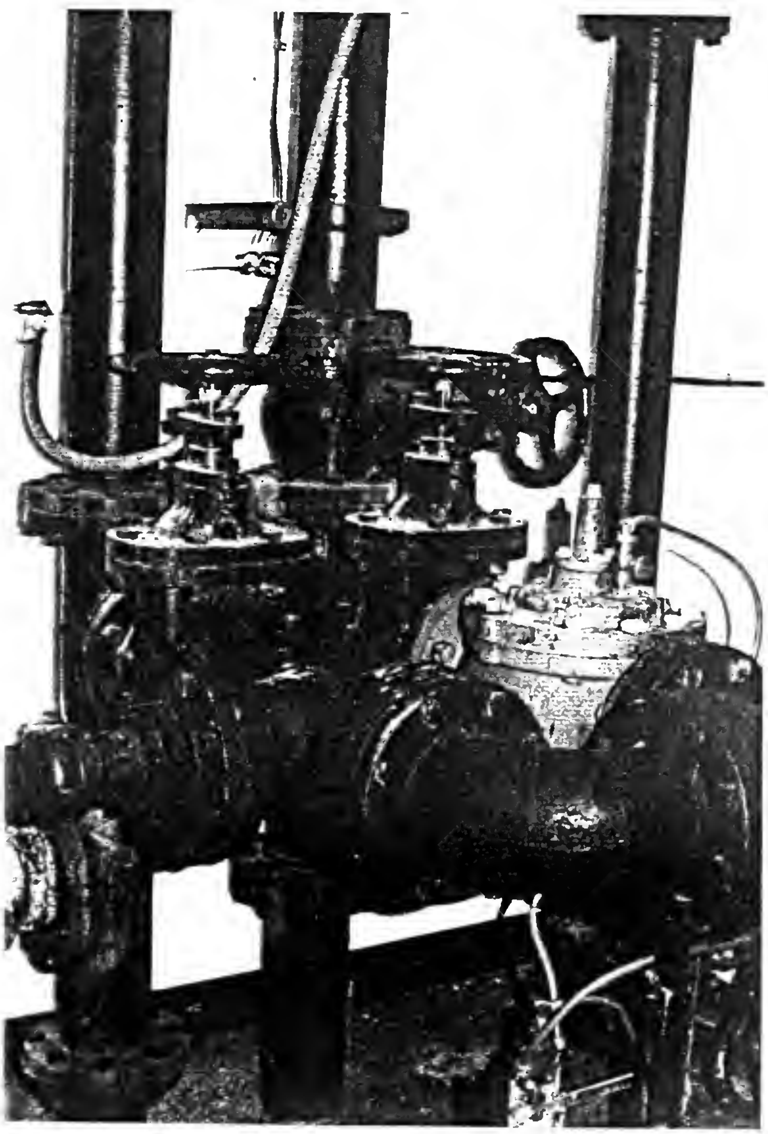


PHOTO NO. 12

WHITNEY

PRESSURE
REDUCING VALVE

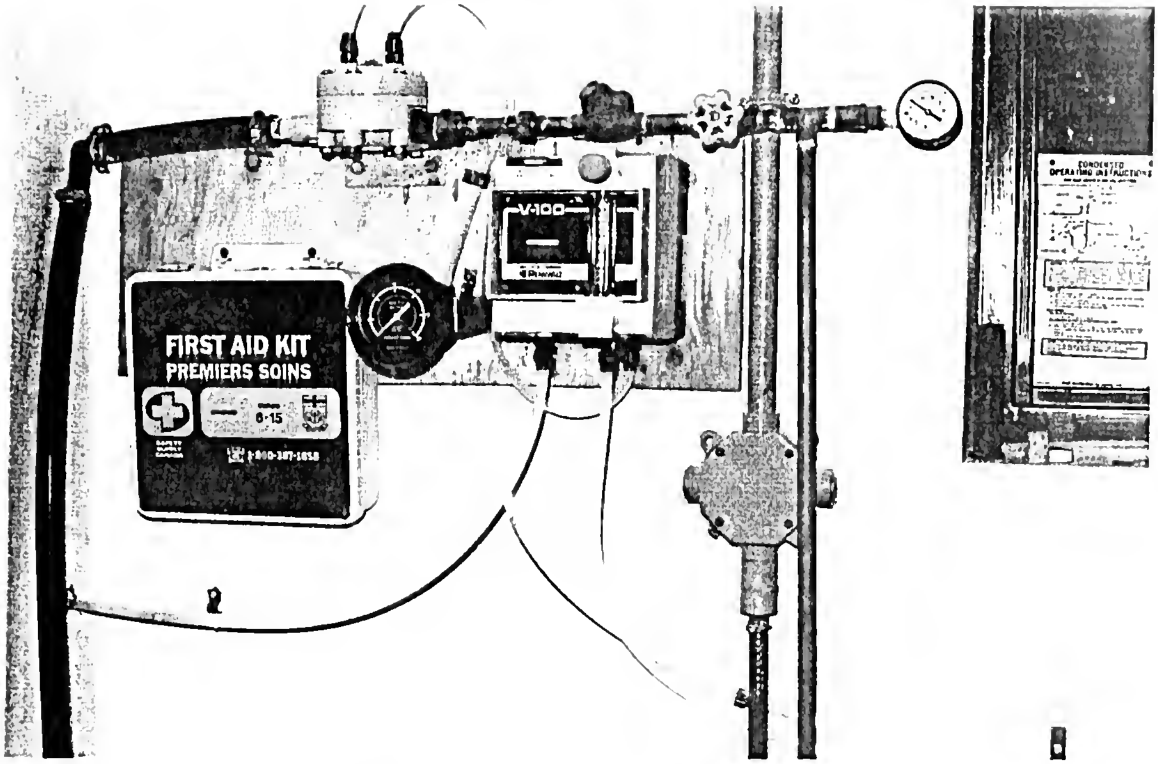


PHOTO NO. 13 - WHITNEY CHLORINATOR

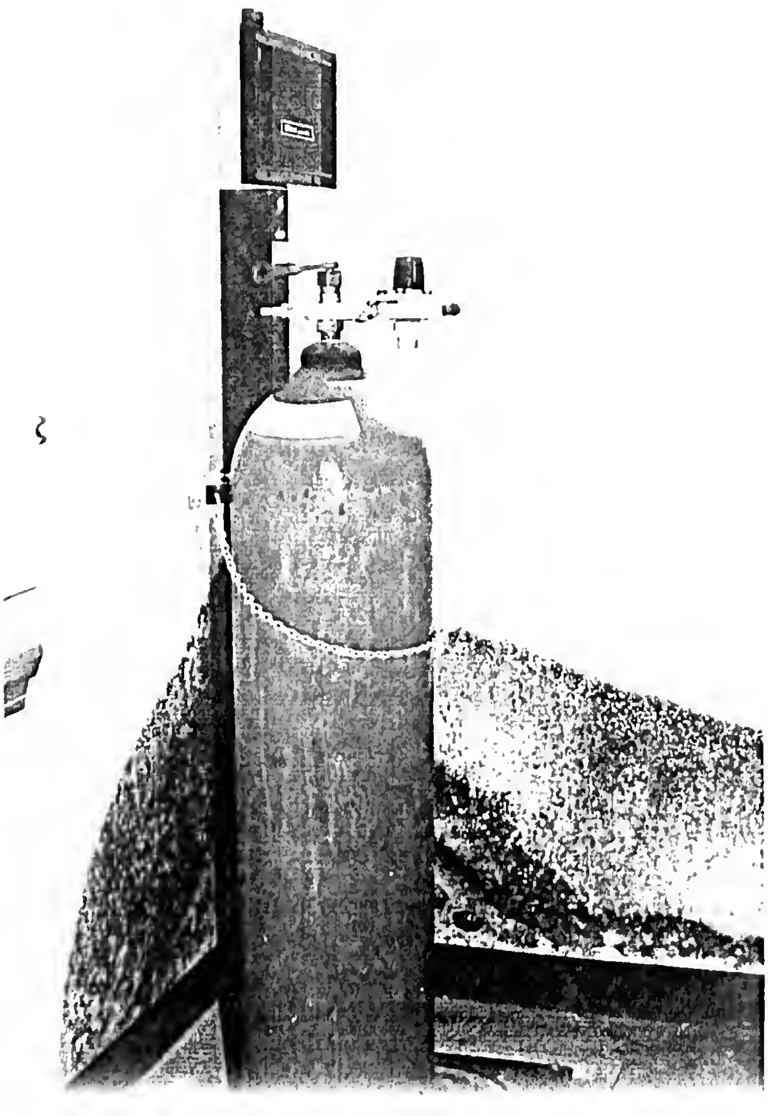


PHOTO NO. 14

WHITNEY

WEIGH SCALE